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SCIENCE

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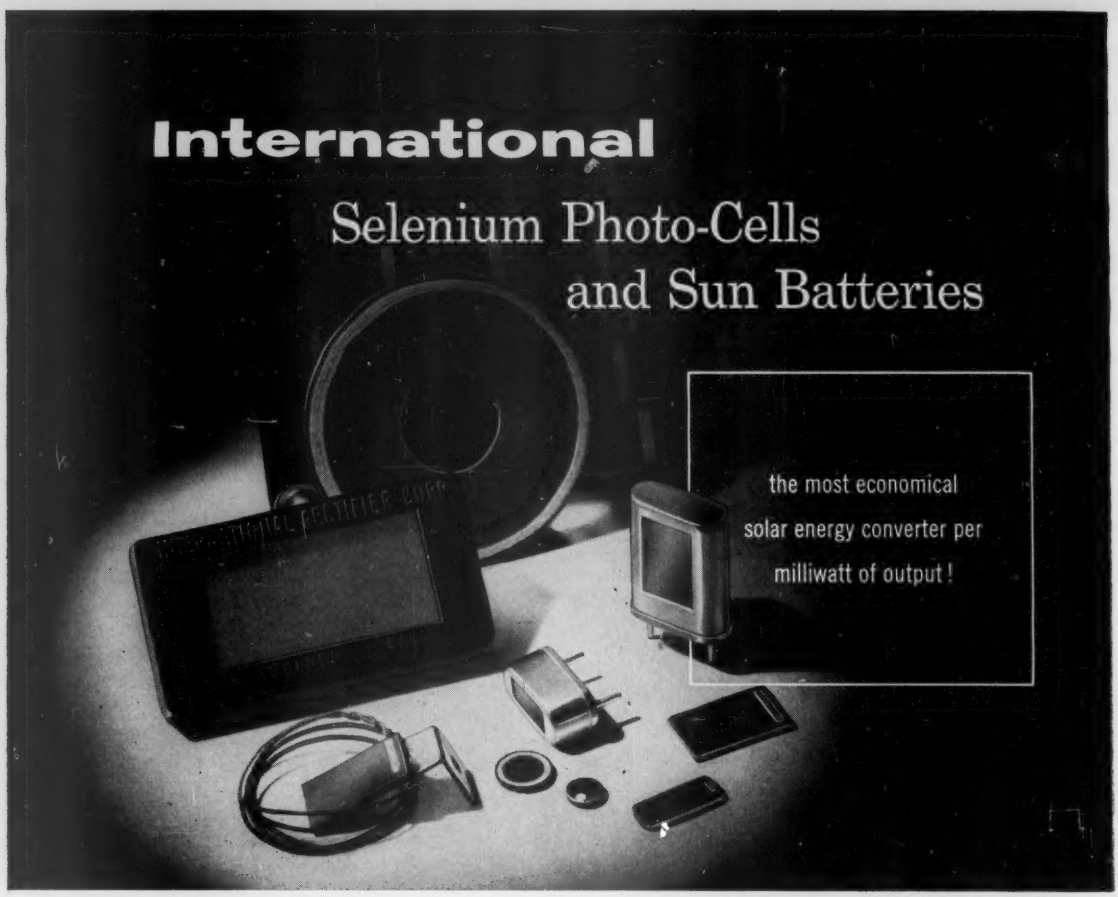

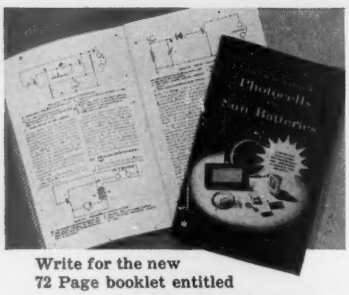

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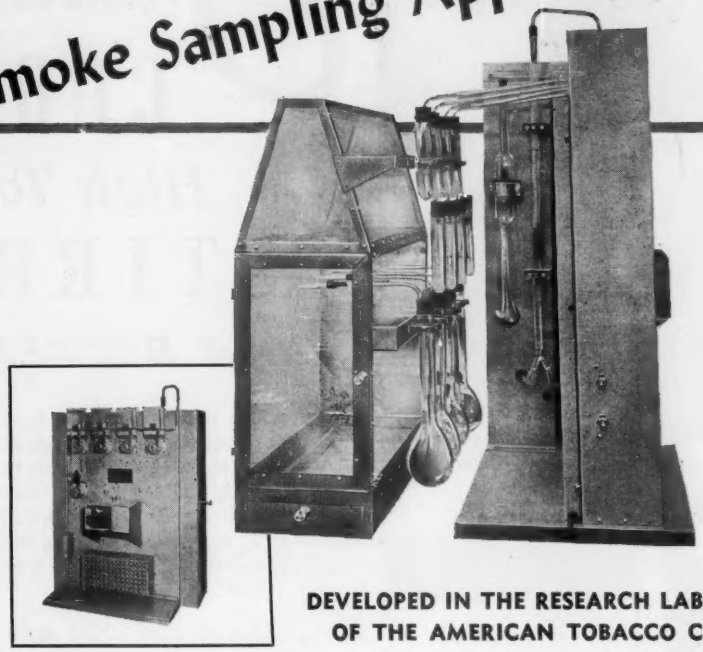

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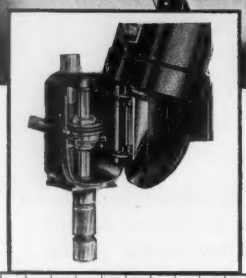

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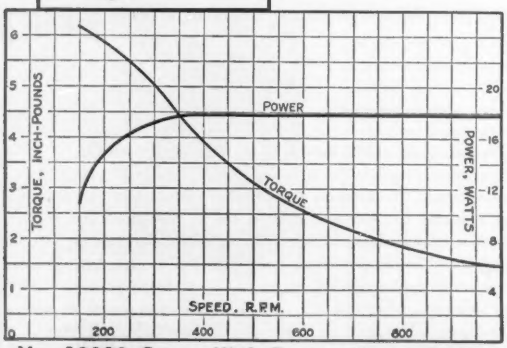

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Wiley Pure Food Laws—a 50th Anniversary

On the occasion of the celebration of the 50th anniversary of the passage of the Food and Drug Laws and the Meat Inspection Law, the Post Office Department issued a special commemorative stamp carrying a picture of Harvey W. Wiley, often and deservedly referred to as the "father" of the pure food laws, for it was his unrelenting crusade that led to the enactment of the first of the laws in 1906. Scientists, government officials, and industrial representatives participated in the celebration, which was held in Washington on 27 June. Some of the participating members of Congress remarked about the unusual situation in which a group of laws are, by common consent, not identified by the name or names of their Congressional sponsors, but rather by that of an "outsider," Harvey W. Wiley. Despite many amendments and modifications since their first introduction, the laws still are identified as the Wiley Pure Food Laws and thus honor the name of the man who fought for their passage in the face of public indifference and industrial opposition.

Perhaps the best proof of the wisdom of Wiley's course is in the current whole-hearted support and sponsorship of the anniversary celebration by the industrial and commercial firms that are subjected to regulation.

This acceptance by industry indicates that we have come a long way since 1906 in matters of government protection of the public health. It is also encouraging to note evidence of cooperation between producers and processors of food, drug, and cosmetic materials and the regulatory agencies authorized to review or control the quality and content of their products. There is often at present a spirit akin to that which prevails in preventive medicine, a spirit that we might term one of "constructive enforcement." An example of this is the common practice of a producer or processor who asks advice in advance about the solution of problems within the regulatory limits. Such advance consultation often precludes the need for litigation to enforce compliance with the laws.

The original Food and Drug Act of 1906 has had to be amended and revised many times, as it will have to be in the future to cope with conditions not expected in the past. New processes of production and processing, such as the production of frozen foods and sterilization by radiation, pose new problems of safe standards for foods, as does the introduction of new pesticides and insecticides.

Although Wiley was best known popularly as the "father of the food laws," his influence in basic science was wide and important. He held doctorate degrees both in chemistry and medicine and was recognized by his fellow-chemists by election to the presidency of the American Chemical Society in 1893. He was a member of the AAAS for 58 years and vice president of Section C (Chemistry) in 1886.

The American Association for the Advancement of Science is pleased with the recognition accorded to one of its outstanding past members, Harvey W. Wiley, and glad to congratulate the appropriate government agencies on the completion of 50 years of advances in the administration of the food and drug laws.—W. R. B.

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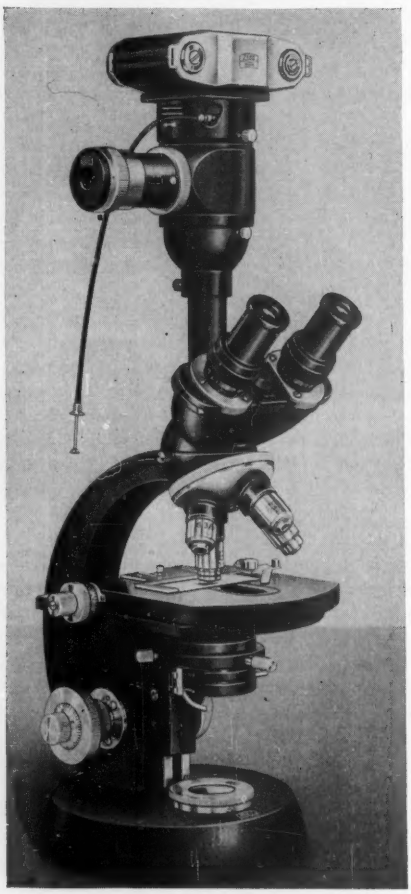

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Molecular Organization of Genetic Material

H. Kacser

From a physicochemical point of view, the cytological and genetical behavior of chromosomes raises two important problems. One is the duplication of a physical entity, the other the replication of specific functional properties. In what follows, the view will be taken that the functional aspect of the genetic material is the more fundamental of the two problems and that duplication should arise as a special case operating under specified conditions. In spite of considerable cytological information about their later behavior, there is little relevant information concerning the chromosomes at the critical duplicating stage. Similarly, although it is certain that functional properties are associated with well-defined portions of the structure, we have no direct evidence how these functions are carried out. By taking biochemical and physicochemical evidence into account, it is possible, however, to arrive at what might be called the minimum requirements for the functioning of the genetic material.

It is convenient to start by discussing the suggestion (*1*) that a proposed structure of crystalline desoxyribose nucleic acid (DNA) is relevant to the genetic problem. The complementary pairing of the bases in the double helix makes it conceivable how two identical double helices could result if a mechanism for their "untwisting" could be imagined. However, "the DNA replicating scheme does not provide a mechanism for separating the two intertwined chains" (*2*). The suggestion (*3*) that systematic breaks take place along the length of the structure avoids the difficulties of "untwisting" but raises problems of equal magnitude in the "systematic breaking."

Although further investigations may prove the proposed structure to be substantially correct (see, for example, Feughelman *et al.*, *4*), it does not, so far, provide a satisfactory mechanism for one of the minimum requirements—namely, the duplication of a physical entity. In any case, the cytological evidence of relic spirals suggests that what "survives" from one division to the next is of an order of magnitude very much greater than the double helix.

It is, however, in the functional aspect that the greatest difficulties of this model are encountered. In the first place, the model fails to account for the protein in the chromosome ("We really have no comparable model for the protein part of nucleoprotein," *5*; see also Watson and Crick, *6*). References to some "nonspecific function" of the protein (*7*) (actually the polypeptide) are unaccompanied by any suggestion how the peptide would be attached to the desoxyribose nucleic acid. Some gallant attempts to close this gap also give no indication how such attachment would be possible (*7–10*). A more rigorous attempt (*4*) envisages combination of the phosphate with the basic amino acid residues only. Even if successful, all such models are concerned solely with polypeptides, while the biological problem is concerned with proteins—that is, polypeptides organized in a specific manner. In fact, the evidence from x-ray scattering (*11*) indicates that protein and nucleic acid, separately organized in large aggregates, constitute the components of native nucleoproteins. The absence of a mechanism for attaching protein to the desoxyribose nucleic acid reflects a more general shortcoming of the model, namely the absence of a mechanism for transmitting to other molecules the specificity that is assumed to reside in the sequence of the bases. Mere duplication of desoxyribose nucleic acid is biologically rather sterile, and consequently the interest of this interpretation of x-ray diffraction is somewhat reduced.

The model that we would like to propose does not concern itself with detailed arguments of particular crystalline structures, which are the proper domain of x-ray crystallography. It is probably not incompatible with the structure of desoxyribose nucleic acid currently held or any other that might emerge. It proposes a mechanism for the chromosome's functional properties which result in the duplication of the structure under specified conditions. The main assumptions are that the chromosome is a "solid phase" (that is, that the system of the nucleus is heterogeneous in the kinetic sense) and that the functional properties are essentially catalytic in nature. It envisages the structure as consisting of an adsorption complex between protein and nucleic acid, the interface of which constitutes the functional part of the assembly.

Surface Specificity

Perhaps one of the most discussed hypotheses arising from the body of biochemical genetics is that the main (if not the only) function of the genetic material is the determination of the specificity of macromolecules, such as various antigens and general proteins and possibly enzymes. The evidence points strongly to a close connection between the genes on the one hand and enzymes and antigens on the other. Whatever the merits of the "one gene-one enzyme" hypothesis, it is clear that the carrier of the genetic material, the chromosome, must be responsible, directly or indirectly, for the production of the enzymes and the antigens or that it must participate in such production in a critical way. We further know that the enzyme, with regard to its specificity and probably its catalytic ac-

The author is a member of the staff of the department of animal genetics, University of Edinburgh, Edinburgh, Scotland.

tivity, acts through its surface and that it is the surface structure which gives the antigen its specific property. In consequence, it is with these surface specificities that the chromosome must be concerned. This function of the chromosome will itself involve a surface since surface specificity cannot be transmitted by anything less than a surface.

The argument that the determination of sequence of the units constituting the macromolecules is sufficient to account for their specificity can be shown to be inadequate. In the case of the proteins and enzymes, for instance, we know that the specificity depends on the particular way in which they are folded or assembled. That this is not fully determined by the sequence of the amino acids is shown by the fact that these structures can be denatured, with a consequent change (or loss) in specificity. This change is due, not to a change in the sequence within the polypeptide, but to a change in organization of the polypeptide within the more compact protein. Denaturations are spontaneous processes, resulting in structures of lower free energy. If nothing but sequence were genetically determined, spontaneous assembly or folding would result in these lowest free energy structures—which is contrary to the evidence.

Some additional mechanism producing assemblies of low entropy must therefore be involved. This is possible if a surface is provided which can determine sequence as well as intersequence organization. This is the familiar template concept, but it should be pointed out that this argument does not necessarily involve a commitment to a particular theory of protein synthesis. All that is implied is that the chromosome should contain specific surfaces, no matter how indirect or by what mechanism the surface specificity is eventually transmitted to its metabolic descendants. The interface of the nucleoprotein complex would fulfill this requirement by providing such surfaces.

There is, of course, another conceivable mechanism—namely, the stepwise assembly of units in a manner similar to the reverse process in, for example, the stepwise degradation of proteins. There is, however, no convincing evidence that such intermediate compounds are formed. In any case, it would involve the presence of specific enzymes for each step—an argument resulting in an infinite regress. (It should be noted that this does not imply a denial of stepwise assembling as a mechanism of processes subsequent to the initial transfer of specificity.) A stepwise folding could equally yield low-entropy structures. If this process is not surface controlled, it implies essentially a rate control. This would be subject to the usual variations of concentration, temperature, *p*H, and so forth; hence it is difficult to see how an invariable product could be produced even if such mechanisms were known. In contrast, surface mechanisms are in fact known to operate in biological systems, and therefore preference will be given to this type of process in the ensuing sections.

Variability

Specificity associated with variability (in the allelic sense) is another important property which must be accounted for. The constituents of the genetic material must be capable of being organized in a very large number of ways. The specificity from point to point on the surface of an assembly of elementary units (amino acids or nucleotides) depends on both the nature and the relative position of the surface groups present, but it will be relatively unaffected by the nature of the underlying "internal" structure. The large number of possible combinations and relative positions of the constituents of proteins and nucleic acid makes it evident how a very great number of highly specific surface configurations can arise. If it is granted that the area of a specific "patch" extends beyond the width of a peptide or a double helix, the influence of neighboring chains permits extremely subtle variations to be imposed on the "shape" of the surface forces, for instance, by simply shifting the relative positions of neighboring units.

While these surface configurations are in our view functionally important, the underlying organization, constituting the bulk of the assembly, may conform to any regular pattern appropriate to the crystal properties of the molecular species in question. There is good evidence that native protein and nucleic acid are paracrystalline (see Feughelman *et al.*, *4*)—that is, that they contain a large fraction of imperfectly crystalline material. Such assemblies may show a sufficiently orderly arangement of the crystalline portions to allow x-ray determination of their structure to be carried out. Such methods, however, can give no information about the amount of cross-linkage or branching, let alone the nature of a surface a few angstroms in depth.

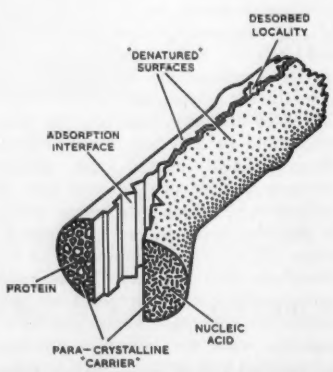

Fig. 1. Diagrammatic view of genetic material.

We take the view that both the protein and the nucleic acid contain specific surfaces and that in fact they form an adsorption complex. Since most of the hydrogen-bonding portions will be internally occupied, the main forces operating on the surface will be van der Waals and coulombic forces. These are short range in nature and therefore demand a very close approach for any potential adsorbate. Unlike hydrogen bonds, these surface forces depend strongly on the nature of the substituents and hence present a highly specific force field. Since the heat of adsorption, a measure of the "tightness of binding," depends on the "area of interaction," it is clear that, if conditions for good adsorption are to be fulfilled, the adsorbate must be "complementary" to the surface. If the adsorbate is itself a surface, it means that, if two such surfaces are adsorbed, their surfaces represent mirror images of force distribution.

Stability

The adsorption complex of protein and nucleic acid is therefore envisaged as containing an interface generated by the complementary surfaces of the two moieties each of which consists of paracrystalline assemblies of the appropriate molecules (Fig. 1). The external surface of the whole complex is not regarded as specific or functional but rather as a denatured surface—that is, a surface having lowest free surface energy and random structural organization. The functional pattern, the genetic "information," is therefore considered to lie only "inside" the genetic material. Like all structures of high free energy content, this pattern will be subject to "decay" in the same manner as proteins and enzymes are denatured and inactivated. Apart from the free energy of activation for this decay, there is another mechanism which tends to maintain surface structure intact. This, in the case of enzymes, is the well-known phenomenon of stabilization by substrates or analogs. The sorption equilibrium between enzyme and substrate "protects" the surface for part of the time so that the rate of inactivation is reduced. With these small molecules as adsorbates, the rate constants of the sorption process are high

and the thermodynamic constants are such that the enzyme is protected only part of the time. An increase in molecular weight would reduce the rate constants, and an increase in the area of interaction would increase the heat of adsorption; both factors tend to increase the stabilization. With two complementary surfaces belonging to high-molecular-weight molecules, the stabilization of one by the other would tend to be exceedingly high. This high stability is, of course, another requirement of a genetic material. That the stability is not absolute is inevitable and may have evolutionary significance. The protective effect may be one of the biological reasons for the existence of two substances in the chromosome (*12*). Another will be evident from the following consideration of the duplication process.

Autosynthesis

When one is discussing the synthesis of new genetic material, it is not helpful to explain it in terms of the hypothetical property of a substance or body called a "self-duplicating ability." No property of this type is known for any molecule except the trivial one of autocatalysis, where already preexisting material is released. The relevant phenomenon is autosynthesis which is the property of a *system*. The general kinetic conditions have been carefully analyzed (*13, 14*) for homogeneous systems. The existence of chromosomes, however, raises problems of macromolecular mechanics not immediately evident from a purely kinetic treatment.

For this purpose, we shall treat the genetic material as a solid phase formed from soluble precursors, the nature of which need not be specified at this stage. Consider the system

$$n\,A + m\,B \leftrightharpoons C$$

where the component C is a solid. The equilibrium constant for this system is defined by the product of the soluble reactants only, the active mass of a solid phase being constant.

How quickly the equilibrium is approached, however, will, apart from concentration considerations, depend on conditions favoring crystallization, since C is a solid. If the structure of C is complex, there will, in the absence of nuclei, be a long delay before the onset of crystallization. Systems with high negative entropies of crystallization may remain supersaturated for very long times. Conversely, the provision of suitable surfaces, particularly the system's "own" lattice, will provide ready centers for rapid crystallization. In such a case, the rate of production of C may depend only on the supply of A and B.

When there are several ways in which A and B can combine to form a number of solids, say, C_1, C_2, C_3 . . . C_n, and if the free energy of the various C's does not differ greatly, the presence of a particular component, C_4, will result in the nearly total conversion of A and B into C_4 only. This is, of course, not an equilibrium state, but may have any desired degree of metastability if the free energies of activation for transitions are sufficiently high. We therefore see that, if two (or more) components can associate in more than one way, the actual solid produced will be strongly influenced by the presence of any preexisting surface structure and in the case of a complex compound may be entirely determined by it.

The idea that chromosome duplication is akin to crystallization has been expressed by various authors. There are a number of objections to the unqualified application of this simple view. If a "template" is said to be responsible for the "guiding" of the new material to produce a new crystal, then (unless the template has a high degree of symmetry) it will produce a crystal with a mirror image template. It has been suggested that this objection may be overcome by allowing this second complementary structure in turn to produce a third, its complement, which would be identical with the original. There is, however, no evidence that three structures are involved in the process, as this idea suggests.

There is one type of structure, with any desired degree of asymmetry, which could result in an identical unit by a single act. This structure consists of two parts joined by an interface. The face of each part is the complement of the other. Which of these would be designated "the template" is a verbal matter only.

Duplication

The processes that take place in organisms are rarely simple. As a rule, they are the result of a large number of coordinated reaction sequences, and this is certainly true of cell division and chromosomal duplication. For the present purpose, however, we need only consider the interaction of the solid-phase adsorption complex with soluble precursors no matter how the supply of these may be controlled. Since the "external" surface of the complex is regarded as denatured, it follows that the only surface which can readily initiate new solid-phase formation is the one that carries the specific genetic pattern. The availability of this interface will depend on the frequency of desorption of its parts. Any portion of the structure that has accumulated sufficient thermal energy may separate by desorbing but, since adjacent portions are still adsorbed, it cannot "leave," and the tendency of the distorted structure to straighten out will bring the two portions together again. All along the length of the structure these desorption-adsorption openings may occur, but the probability of the whole structure separating at the same time is very small. While the probability of separation at any point is roughly the same, there are two points, the ends, where they may be more frequent. If an end portion separates, the tendency to close again operates only from one side and therefore this portion may stay open longer, or separate more frequently. These end portions may therefore be positions where the laying down of new material is more likely to begin. Sorption equilibrium is of course sensitive to the conditions of the medium such as ionic strength and *p*H, and a change in these conditions may be instrumental in beginning the process (Fig. 2).

The nature of the sorption forces involved will ensure that the first layer has a close "fit"—that is, will result in a precise complementary surface. Only certain molecules and sequences will be stereochemically suitable for particular portions of the surface. Particular amino acids will best fit the relevant nucleic acid surface and similarly for nucleotides on the protein surface. The situation is not altered if it is assumed that more

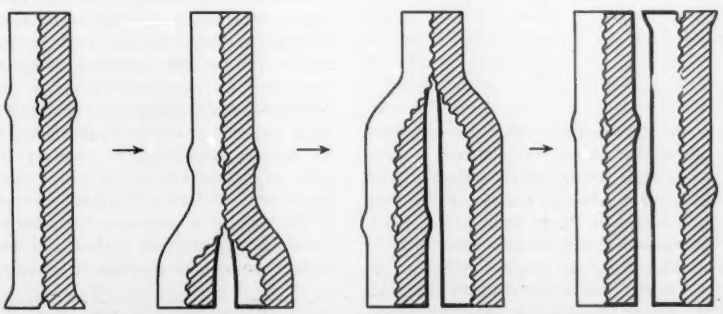

Fig. 2. Diagrammatic view of duplication of absorption complex.

complex condensation products of the simple precursors are supplied. While the first layer will be formed in this manner, further building up will take place by covalent and hydrogen bond formation. This can proceed rather easily since both these bonds are relatively unspecific and consequently may have greater freedom with respect to the nature and sequence of the units. This is because the entropy of adsorption onto a specific surface is very large (and negative), whereas the entropy of hydrogen and covalent bonding is much smaller.

While adsorption is a spontaneous process, the building up of the main bulk of the structure requires the supply of free energy mainly for covalent bonding. If we assume that this is effected by coupling with free energy-yielding reactions, duplication may be triggered by conditions determining these reactions which may also be rate determining.

Once the process has started at one point, wherever that point may be, it may continue along the interface in a zipper-like fashion since the building up of the material will always result in an "open" portion just in front. The supply of the complementary precursors need not be strictly synchronous. It is seen that eventually two structures are obtained, one containing "old" protein and "new" nucleic acid, and other "new" protein and "old" nucleic acid, provided that no sister strand crossing over takes place. However, the two structures are identical as far as internal surface structure is concerned. The building up of the paracrystalline "carrier" will terminate when, for example, the surface volume ratio reaches a critical value, possibly determined by such factors as surface energy or charge density or when the supply of some critical material is exhausted. This final size, however, will be influenced by factors of the environment such as temperature, concentration, hydration, *p*H, and so forth. It is also possible that the composition of the bulk material could vary within limits since strict specificity requirements are operating only in the surface layer. The supply of precursors, controlled by the system as a whole, may, however, be considerably buffered, tending to produce identical structures.

We thus have a mechanism whereby a solid structure is duplicated and at the same time a replication and preservation of a specific interface takes place. We may identify this structure with the chromosome, but the diagrammatic view of Fig. 1 is not meant to imply that the interface necessarily runs along the chromosome axis, nor that it is dimensionally correct, nor, indeed, that this is the only way adsorption complexes can be organized into one structure. Variations of the model could, for example, account for "discreteness" of the genetic material in the chromosome. (Chromomeres? see also, Mazia, *15*).

The special conditions described here in some detail do not necessarily apply to all structures containing genetic material nor to all variations of a changing system of which it forms a part. Thus, for instance, the evidence that in certain systems (phage, transforming principle) the nucleic acid only is transferred is not incompatible with the idea that the participation of this material in the host's cell economy results in the same *type* of structure as discussed here. Neither is the principle of the duplicating mechanism restricted to desoxyribose nucleic acid as one of the participants. The evidence that the plant viruses contain ribose nucleic acid only (where one definitely does not find base pairs) should serve as a reminder that genetic mechanisms should not be looked for in the properties of particular substances but in the way the whole system is organized (*16*, *17*).

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16. A discussion of these aspects and the problems connected with meiosis, mutations, and differentiation is in preparation.

17. My thanks are due to my colleagues for helpful criticism. The basic ideas underlying the present approach were developed in discussions with Per Oftedal during his stay in this department in 1952.

Lamont Natural Radiocarbon Measurements III

W. S. Broecker, J. L. Kulp, C. S. Tucek

The previously published radiocarbon measurements from this laboratory (*1*, *2*) were made in 1950–1952 with the black-carbon method (*3*, *4*). Subsequent to this period, the increasing frequency of atomic tests and, later, the larger shots which produced continuous long-term fallout, caused sufficient air contamination to render the black-carbon method unreliable unless elaborate precautions were taken and multiple runs were employed. By the end of 1953, the pioneer work of de Vries and Barendsen (*5*, *6*) with carbon dioxide and Suess (*7*) with acetylene had shown that proportional gas-counting methods have some distinct advantages. A gas proportional-counting system was then designed and constructed at Lamont Observatory (*8*). This paper (*9*) reports the results obtained by the black-carbon method during 1953 which are considered reliable and those obtained by the new carbon dioxide proportional-counting method.

Techniques, Assumptions, and Errors

The carbon dioxide proportional-counting system is superior to the black-carbon method for several reasons: (i) it has virtually 100-percent counting efficiency compared to 6-percent; (ii) it is free from air-borne fission product contamination; and (iii) it can be readily adapted to samples containing as little as 0.1 gram of carbon. The use of carbon dioxide is preferred over acetylene because of the absence of explosion hazards, the possibility of going to higher pressures with a consequent increase in sample/

The authors are on the staff of the Lamont Geological Observatory, Columbia University.

background ratio, the absence of fractionation during preparation, and the ease of preserving the sample after counting. The carbon dioxide proportional system was selected for routine assay over the liquid scintillation technique because of the simplicity in sample preparation, the absence of fractionation, and the ease of reproducibility of background and counting efficiency.

The new technique involves the conversion of the carbon in the sample to very pure carbon dioxide, which is then placed in a large-volume (5-liter) proportional counter at a pressure of 1 to 2 atmospheres. Three counters have been in routine operation; the characteristics of each are given in Table 1. The small counter is used for samples containing less than 1 gram of carbon.

The ages given in this paper are given in carbon-14 years on the basis of a half-life of 5568 ± 40 years. If the integrated cosmic ray flux has been constant over the past 50,000 years (*10*), if the samples have not been subject to field contamination, and if the proper contemporary value for each sample type is selected, the carbon-14 ages will be in actual years. There was negligible isotopic fractionation in the preparation of these samples. Fractionation in nature appears quite limited (*11*) and would only produce detectable effects on near-modern samples. The relative sequence of ages is independent of the half-life used and very insensitive to changes in the cosmic ray flux.

The error quoted for the ages is a combination of errors from three sources: statistical uncertainty, background fluctuations, and variations in efficiency. In most cases, the background fluctuations were no larger than those expected from statistical fluctuation alone, but during certain periods they exceeded this, introducing somewhat larger error in the determination. These variations can be correlated with extreme atmospheric pressure changes. The variations in efficiency are for the most part much less than 1 percent. This can be checked by the use of an external gamma-ray source. Two or more measurements were made on the majority of samples reported. In a few cases where only limited accuracy was necessary, the age quoted is based on only one determination.

The errors on a given measurement are calculated as follows:

$$E_{R_i} = R_i \sqrt{\left(\frac{E_{S_i}}{S}\right)^2 + \left(\frac{E_{\overline{M}}}{\overline{M}}\right)^2}$$

where E_{R_i} is the error in the individual ratios of sample count rate to control count rate; E_{S_i} is the error in the sample count rate; $E_{\overline{M}}$ is the error in modern control count rate; S_i is the sample count rate; $\overline{M}$ is the average modern control count rate; and R_i equals $S_i/\overline{M}$ (age computed directly from this ratio)

$$E_{S_i} = \sqrt{E_{T_i}^2 + E_{B_i}^2}$$

where E_{T_i} is the error in the total count rate and E_{B_i} is the error in the background count rate.

$$E_{\overline{M}} = \sqrt{\frac{(\overline{M}_i - \overline{M})^2}{n(n-1)}}$$

where $\overline{M}$ is control count rate.

$$E_{T_i} = \sqrt{s_T^2 + e_{S_i}^2}$$

where s_T is the statistical error in total count (1 σ) and e_{S_i} is the error due to uncertainty in efficiency.

The error in the background count rate (E_{B_i}) is estimated from the scatter of background values around the mean for a given period. Rarely does it exceed a factor of 2 times the statistical error for a given background measurement.

Minimum ages are given if the average net count lies within twice the error of zero activity. Therefore, only four or five in 100 given minimum ages should fall below the stated limit.

Table 1. Comparison of counter characteristics (counts per minute for background and modern wood). Counters 1 and 2 have an active volume of 4.9 liters; counter 3 has an active volume of 0.5 liter.

Counter No.	1 atm		2 atm	
	Background	Modern wood	Background	Modern wood
1	15.0	29.0	17.5	58.0
2	12.0	30.2	14.5	60.5
3			3.0	5.6

Results

The natural radiocarbon measurements are arranged in five tables (Tables 2 to 6) for convenience. The samples are grouped according to the primary field of interest—that is, geology or archeology—and by the method used in the assay. The data for the separate study on deep-sea cores are shown in Table 6.

Some comparison and calibration data should be noted. First, in most cases the ages obtained both by the carbon dioxide method and black-carbon method agree within the experimenal error (see Table 4, samples L-219, L-125, and L-214; and Table 5, samples L-115 and L-116A). Evidence for fission-product contamination has been detected in some cases [Table 5, sample L-195; and Suess (*12*), samples W-76 and W-77, which were reruns by the acetylene method of samples L-117A and L-117S (*1, 2*), which had been measured earlier by the black-carbon method].

The relative accuracy of the carbon-14 dates is shown again in the detailed stratigraphic suite of samples from Nazca, Peru, shown in Table 5. Several interlaboratory calibrations are available—see samples L-167A in Table 2, L-214 in Table 4, L-182 in Table 5, Suess's sample W-40 (acetylene) (*7*) and Lamont's sample 103B (*1*). Other laboratories have concurred on the Two Creeks, Wis., date at about 11,500 years before the present, and several of the European laboratories have agreed on the Gröningen Church wood standard at about 1000 years before the present (*13*). Some of the early Chicago black-carbon dates appear to be too high—for example, the Gröningen Church was reported to date about 2200 years before the present (*14*). An additional instance of this can be seen in the comparison of sample L-214 (Table 4) for which three laboratories using two different techniques agreed on a date of 5200 years before the present, while Chicago obtained 6440 years before the present (*14*) (see also the discussion in Table 5 on samples L-115 and L-116A).

These new data also give several comparisons of different sample materials from the same site—that is, charcoal and shell (samples L-188C, L-201A, L-188A, and L-188D in Table 3), charcoal and wood (samples L-188B and L-188E in Table 3), and fresh and decayed wood (samples L-223A and L-223B in Table 2). The agreement in all cases is within the experimental error.

It is concluded that the errors stated are a reasonable index of the reproducibility of a measurement, that with the new techniques agreement between laboratories is excellent, and that there is no evidence of contamination in any of the measurements obtained by the gas-counting methods.

Studies of ocean-sediment cores made at the Core Laboratory of the Lamont Geological Observatory indicate that the transition from the Wisconsin glacial period to post-glacial time was marked by a rather sharp climatic change throughout the Atlantic Ocean and Caribbean Sea about 11,000 years ago. The lithologic and paleontologic data and a discussion of the implication of these results will be published separately (*15*). The carbon-14 dates on some of these cores are given in Table 6. All measurements were made on bulk core material. A value close to that of modern wood was used as an estimate of the initial carbon-14 activity of the carbonate in the sediments. Recent measurements on ocean water samples indicate that this assumption should introduce an error of no larger than 300 years.

Table 2. Radiocarbon dates obtained on geologic samples by the black-carbon method. All ages are given in radiocarbon years before the present.

Description	Sample No.	Age
I. *North America*		
A. *Alaska*		
1. *Cook Inlet area*		
Kasilof, Kenai Peninsula. Decomposed wood and bark from culture layer overlain by 3 in. of loess covering floor of house pit. On the basis of dendrochronology and the radiocarbon date, it is estimated that the site was last occupied between 250 and 350 yr ago. Other lines of evidence, both botanical and geologic, suggest that the radiocarbon date may be too young. It is not unlikely that the sample was contaminated by younger carbon, for it was collected well within the root zone of the present vegetation mat. Collected by T. N. V. Karlstrom, U.S. Geological Survey, Washington, D.C., in 1951.	L-137E	450 ± 200
Boulder Point, Kenai Peninsula. Samples from base of 18-ft-thick organic silt deposit. L-117O was taken 2 ft below L-163B. Collected by T. N. V. Karlstrom.		
Wood fragments.	L-163B	8650 ± 450
Peat.	L-117O	8200 ± 900
Boulder Point, Kenai Peninsula. Buried log from basal outwash exposed in sea cliffs north of Boulder Point. Collected by T. N. V. Karlstrom.	L-117M	> 25,000
Homer. Log fragments under 6 ft of slope wash and landslide debris and 8 ft above a buried till near Homer. Indicates that lower Kachemak Bay was ice-free long before 2250 yr ago. Collected by D. B. Krinsley, Alaska Division, U.S. Geological Survey, Washington, D.C., in 1950.	L-137K	2250 ± 300
Ninilchik, Kenai Peninsula. Wood from base of 10-ft peat section overlying 20 ft of stratified sand and gravel resting on gray till. The underlying gravel is interpreted as channel gravel deposited on old till and related to the Naptowne end moraines near Tustumena Lake. Dates the beginning of peat accumulation in late- or post-Naptowne time. Collected by D. B. Krinsley in 1951.	L-137L	9600 ± 650
Point Possession, Kenai Peninsula. Two samples were collected from separate localities outside the boundaries of the last major glaciation (Naptowne) as described from the Cook Inlet area (Karlstrom, in Péwé *et al.*, *16*) and from apparently similar stratigraphic zones. The close agreement in age is striking and bears on the validity of the radiocarbon method in dating geologic events. Both samples were collected from buried organic deposits separated from underlying drift by a stratified-to-massive blue-gray silt with scattered pebbles and cobbles considered to be a glaciolacustrine deposit related to the Naptowne advance. Collected by T. N. V. Karlstrom in 1951.		
Compressed and deformed peat at top of organic silt overlain by 15 ft of stratified sand and silt in cliff on south shore of Turnagain Arm.	L-137C	9500 ± 650
Organic silt under 30 ft of stratified sand and silt in exposure 3 mi east of collecting site of sample L-137C.	L-163D	9200 ± 600
Hope Junction, Kenai Peninsula. Basal wood from 5-ft section of alternating sequence of peat and organic silt overlying glacial lake silts exposed in road cut of Anchorage Highway near Hope Junction. Collected by T. N. V. Karlstrom in 1953.	L-237F	6800 ± 550
Ingram Creek, Kenai Peninsula. Woody peat from base of alternating peat and silt section 5 ft thick overlying till and bedrock exposed in road cut of Anchorage Highway near head of Ingram Creek. Collected by T. N. V. Karlstrom in 1953.	L-237G	4500 ± 450
Kenai, Kenai Peninsula. Lignitized log at base of 50-ft section of iron-stained and flexured gravel overlying glaciolacustrine or -estuarine deposits, 3 mi north of Kenai in sea bluff.	L-137D	> 24,000
2. *Seward Peninsula*		
Throughout the Seward Peninsula, organic material can be obtained from muck deposits that fill valleys of minor streams which are commonly underlain by blue-gray silt or by an older muck that contains fossil remains such as elephant, horse, and bison, which are conspicuously absent in the dated muck. Locally, the dated muck overlies thin gravel containing remains of extinct mammals. Until recently it has not been possible to correlate these deposits with any known chronology, and their origin and climatic significance have been obscure. These dates, coupled with previously published dates for samples L-117C and L-117D (*2*), demonstrate that the muck has been accumulating more or less steadily from more than 10,200 yr ago to less than 450 yr ago. The contained plant remains suggest that the muck has accumulated during periods when open forests of birch and poplar were present in the valleys as well as during periods, such as the present, when trees were lacking. Samples from zones containing remains of large birch and poplar trees not present in the area today suggest warmer periods, or at least periods with warmer summers, centered about 3600 yr ago and from 8300 to 9500 yr ago. Buried beaver dams indicate beaver activity about 3600, 8350, and 9500 yr ago in an area which is from 50 to 100 mi beyond the range of modern beavers. Finally, the fossil fauna of the Pleistocene appears to have become extinct on Seward Peninsula much more than 10,000 yr ago.		
Peat overlain by 8 ft of muck; upper Coffee Creek, Bendeleben B-6 Quadrangle. Collected by R. S. Sigafoos, Alaska Division, U.S. Geological Survey, Washington, D.C., in 1950.	L-137F	2750 ± 350
Wood overlain by 10 ft of frozen muck; lower Coffee Creek, Bendeleben B-6 Quadrangle. Collected by R. S. Sigafoos in 1950.	L-137G	10,200 ± 800

Description	Sample No.	Age
Wood overlain by 15 ft of muck; Candle Creek, Bendeleben D-1 Quadrangle. Collected by D. M. Hopkins, Alaska Division, U.S. Geological Survey, Washington, D.C., in 1949.	L-137N	9400 ± 750
Wood from muck at head of Black Gulch, Bendeleben C-5 Quadrangle. Collected by D. M. Hopkins in 1948.	L-117E	8800 ± 1000
Wood from buried beaver dam on Mud Creek, Candle D-6 Quadrangle. Collected by D. M. Hopkins in 1949.	L-117E	3600 ± 500
3. *Bristol Bay area*		
Nushagak Bay. Peat toward base of 6-ft organic section over stratified fine sand, at mouth of abandoned slough west of Dillingham. Places a ceiling on a level of the sea several feet higher than at present, tentatively correlated with the "postglacial climatic optimum." Collected by E. H. Muller, Alaska Division, U.S. Geological Survey, Washington, D.C., in 1951.	L-137J	3600 ± 400
Naknek, Alaska Peninsula. Peat in poorly stratified blue-gray silt overlain by 35 ft of stratified sand and silt. Below the peat, stratified silt contains striated cobbles and overlies till exposed at Cape Suworof, ½ mi to the east. Places a ceiling on till at Cape Suworof, implying a pre-Wisconsin age. Collected by E. H. Muller in 1951.	L-137I	> 30,000
Cape Greig, Alaska Peninsula. Peat over till and underlying 35 ft of lacustrine sand and silt. Dates an interval of peat accumulation shortly after glaciation of Cape Greig. Coarse sand and gravel immediately above may be related to a moraine 8 mi to the east at Pilot Point, which is considered to be of Brooks Lake equivalence (Muller, in Péwé *et al., 16*). Collected by E. H. Muller in 1951.	L-137H	12,750 ± 1100
4. *Other localities*		
Chena River. Wood from 4- to 12-in. peat bed overlain by 5 ft of gray-brown silt and 1 ft of surface peat from bluff on south bank of abandoned channel of Chena River, ¼ mi from river, at long. 146°43.3′W, lat. 64°52.3′N. Collected by J. R. Williams, Alaska Division, U.S. Geological Survey, Washington, D.C., in 1950.	L-237A	8450 ± 700
Kobuk River. Samples collected by A. T. Fernald and D. R. Nichols, Alaska Division, U.S. Geological Survey, Washington, D.C., in 1952.		
Tree trunk from organic zone overlying till and overlain by 35 ft of stratified silt and sand.	L-237C	24,400 ± 4000
Silty peat from 35-ft section of sand and intermixed organic material overlain by 75 ft of dune sand.	L-237D	> 24,000
Log from 15-ft depth in terrace sand and gravel in bluff near Shungnak.	L-237E	2500 ± 300
Fairbanks. Wood from stump in forest bed buried under approximately 50 ft of muck in Dawson cut, 8 mi north of Fairbanks. The stump lies at the base of the muck formation that is tentatively thought by the submitter to be Wisconsin in age and correlates well with samples from other localities in stratigraphically similar horizons—that is, L157A and L158A. Submitted by T. L. Péwé, Alaska Geology Branch, U.S. Geological Survey, College, Alaska.	L-137P	> 24,000
Dome Creek. Series of samples in perennially frozen organic silt (muck) along Dome Creek, 10 mi north of Fairbanks. The stump (L-158A, in place) and muck (L-158B) were closely associated; the wood (L-157B) and bison hide (L-127) (*2*) were slightly higher stratigraphically; and sample L-163H was still higher in the section but well within the permafrost zone. Submitted by T. L. Péwé.		
Wood from upright stump at bottom of section.	L-158A	> 30,000
Muck closely associated with L-158A.	L-158B	> 30,000
Wood 2 ft stratigraphically higher than L-158A but nearby. Total exposed permafrost section, 40 to 50 ft.	L-157B	> 25,000
Wood occurring 40 ft below surface in muck stratigraphically 10 ft above L-158B.	L-163H	> 30,000
Eva Creek. Series of samples in a vertical 100-ft section along Eva Creek, 10 mi west of Fairbanks. Sample L-117H (3750 ± 200 yr) (*2*) was taken in the permafrost zone in the same vertical section at a depth of about 8 ft. Submitted by T. L. Péwé.		
Wood taken 30 ft below surface in frozen muck.	L-163J	> 30,000
Wood from 60 ft below surface in frozen muck.	L-157A	> 23,000
Wood from stump at bottom of section (100-ft depth) in frozen silt.	L-137X	> 28,000
Eva Bench. Fragments of wood in permafrost 9 ft below surface in tan silt, 10 mi west of Fairbanks adjacent to Eva Creek. Submitted by T. L. Péwé.	L-137S	10,500 ± 500
B. *Canada*		
Fraser Valley, British Columbia. Material was taken from base of Sumas till, which is believed to represent the last advance of the ice in the lower Fraser Valley. Submitted by J. E. Armstrong and V. K. Prest, Geological Survey of Canada.		
Small stems and rootlets from Richmix Quarry, Sumas Mountain.	L-221D	11,500 ± 1100
Wood from station 252A, Mount Lehman Road.	L-221E	11,000 ± 900
Vancouver Island, British Columbia. Samples taken from 40-in. peat bed in Quadra group which lies beneath 50 ft of Vashon till. This sequence has been traced from intermittent exposures for a 3-mi length of the sea cliff bordering Georgia Strait. The peat-bearing beds are believed to correlate with similar deposits found throughout the Georgia Basin. Submitted by J. G. Fyles, Geological Survey of Canada.		
Wood.	L-221A	> 26,000
Peat.	L-221B	> 24,000
Lethbridge, Alberta. Sample consists of wood (black spruce) contained in 4 ft of limonitic sand and gravel that is underlain by 78 ft of till. Horberg included these materials in his "Lower Till" which he tentatively assigned to the Tazewell or Cary substage of Wis-	L-221C	> 26,000

Description	Sample No.	Age
consin glaciation. Submitted by A. M. Stalker, Geological Survey of Canada.		
C. *United States*		
1. *West*		
White River, Wash. Logs imbedded in volcanic mudflow deposit originating from the northeast side of Mount Rainier, then flowing down the valley of the White River some 40 mi to the west front of the Cascade range, then some 20 mi farther west into the Puget Sound lowland. Both hard fresh wood and badly decayed wood were run to check the possible alteration in the isotopic composition. Submitted by D. R. Crandell, U.S. Geological Survey, Washington, D.C.		
Fresh wood.	L-223A	4800 ± 450
Decayed wood.	L-223B	4950 ± 450
North Fork Newaukum River, Wash. Fossil wood (fir) in stream bed of river in SW ¼ NW ¼ sec. 35, T14N, R1W, W. M. Abundant, well-preserved limbs and trunks of fossil trees interbedded in sandstone and conglomerate beds of the Astoria formation of Miocene age.	L-228	> 27,000
San Francisco, Calif. Limb of juniper or red cedar, probably *Juniperus californica,* obtained from the west flank of Russian Hill during the excavation of Broadway Tunnel in a crossbedded, silty to clayey sand immediately above a bed of dark gray, sandy clay. This stratigraphic unit is probably part of an unnamed sand formation that underlies the widespread dune sands of the city and the recent muds and clays deposited in San Francisco Bay and that is extensively developed in the Lake Merced-Merced Valley area. It may be correlative with the Temescal formation and Merritt sand of Pleistocene age. Submitted by M. G. Bonilla and J. Schlocker, Engineering Geology Branch, U.S. Geological Survey, Washington, D.C.	L-227	> 27,000
Rozel Point, Box Elder County, Utah. Sample of asphalt that is believed to be one of the youngest natural oils in existence. Submitted by J. M. Hunt, Carter Oil Company, Tulsa, Okla.	L-155	> 30,000
Grand County Utah. Juniper roots penetrating the McCoy group of the Thompson district. Two separate samples. Collected by Helen Cannon, U.S. Geological Survey.		
Juniper roots.	L-150A	< 200
Juniper roots.	L-150B	< 200
Unaweep Canyon, Colo. Charcoal obtained from a hearth in alluvium along East Creek, Unaweep Canyon. The hearth is 6 ft below the top of the alluvium, which is believed to be correlative with the Tsegi-Calamity-Piney Creek alluvial series. Estimated age: 2500 to 3500 yr before the present. Submitted by C. B. Hunt, U.S. Geological Survey.	L-167B	1350 ± 200
2. *Midwest*		
Stump Lake, N.D. Sample from tree stump along shore in SW¼ sec. 32, T151N, R60W, Nelson County. Collected by S. Aronow, University of Wisconsin, Water Resources Division, U.S. Geological Survey.	L-239B	500 ± 400
Curtis, Neb. Charcoal from terrace on Dry Creek, NW¼ sec. 1, T7N, R26W. Collected by J. C. Brice, Washington University, for Water Resources Division, U.S. Geological Survey.	L-239C	2200 ± 300
White Pine, Mich. Log buried beneath 35 ft of clay, north of center of sec. 4, T50N, R42W. Collected by W. S. White, Mineral Deposits Branch, U.S. Geological Survey.	L-239A	12,600 ± 1200
3. *Mississippi Delta*		
Mississippi Delta. Dated samples from the late Quaternary deltaic deposits of the Mississippi can be used to interpret elevations of the sea at the time of sample deposition. The analyses of these samples provide information concerning elevations of the sea following the lowering of sea level in the late Wisconsin maximum. The detailed geology has been covered in a comprehensive report (*17*). The analysis of these dated samples indicates that 10,000 yr ago, the sea was about 100 ft lower than it is at present and that sea level was very nearly at its present level 5300 yr ago. Other geologic information (*17*) indicates that sea level has maintained its stand during the last 5000 yr. Samples L-175D and L-175G, dated 1400 and 350 yr respectively, were laid down in depositional environments associated with standing sea level. In determining the elevation of the sea at the time each sample is deposited, it is necessary to consider the amount of postdepositional downwarping and the elevation of the environment with respect to the level of the sea at the time the sample was buried. The environments of deposition of late Quaternary sediments from which these samples were taken and the amount of structural downwarping have been discussed by Fisk and McFarlan (*18*). Submitted by H. N. Fisk, Humble Oil and Refining Company, Houston, Tex.		
Marine pelecypod shells, surface, mouth of Mississippi River, Plaquemines Parish, La. Surface of mudlump 2000 ft off North Pass.	L-175G	350 ± 250
Large shells from 13-ft depth, Belle Chasse area, Plaquemines Parish Pumping Station, T14S, R24E, sec. 89.	L-175D	1400 ± 200
Marine pelecypod shells from 69-ft depth, same location as sample L-175D.	L-175E	5350 ± 500
Wood from 35- to 45-ft depth, Lake Felicity area, Terrebonne Parish, La., T20S, R20E, sec. 5.	L-175F	6000 ± 550
Wood from 120- to 135-ft depth, Duck Lake area, St. Martins Parish, La., T15S, R11E, sec. 2.	L-175B	9750 ± 550
Wood from 80- to 120-ft depth, North Thibodaux area, Lafourche Parish, La., T14S, R16E, sec. 84.	L-175C	10,900 ± 100
Marine pelecypod shells from 79- to 85-ft depth, University Place and Common Street, Orleans Parish, La.	L-175A	> 30,000
4. *East*		
Damariscotta, Me. Oyster shells		

Description	Sample No.	Age
taken 1 ft above base in one of the largest shell heaps on the west bank of the Damariscotta River. Oysters are no longer abundant in this estuary, possibly suggesting a significant change in climate. This material also afforded a test of the effects of surface contamination. The results suggest slight additions of old carbon to the bulk material, but the results are within stated errors. Collected by W. H. Bradley, U.S. Geological Survey.		
Selected, cleaned shells.	L-160A	1600 ± 250
Bulk material.	L-160B	1900 ± 250
McDowell County, N.C. Well-preserved wood from North Muddy Creek at a point on the stream about 5.2 mi east of Marion, N.C., and 1.3 mi south of Nebo. This specimen is a fragment from a buried log that lies near the base of a peaty blue-gray sandy clay at a total depth of 7 ft beneath the present surface of the flood plain. The log lies immediately above a monazite-bearing gravel that forms the basal aggregate of the fluvial sediments on North Muddy Creek. The clay is overlain by 2 ft of brown sandy silt, which is overlain by 3 ft of red-brown sandy silt. The log appears to have been deposited at the same time as the clay. The upper 3 ft of red-brown sandy silt probably has been deposited since farming began in McDowell County about 150 yr ago. [This sample (W-7) was also dated by Suess at 2270 ± 200 yr (*12*).] Submitted by W. C. Overstreet, U.S. Geological Survey.	L-167A	2680 ± 300
Brantley County, Ga. Organic material from soil samples from the Leon sand. Collected by R. S. Dyal and submitted by L. Alexander, U.S. Department of Agriculture.		
Material from a depth of 17 to 20 in.	L-204A	1150 ± 350
Material from a depth of 88 to 133 in.	L-204B	23,000 ± 8000
South Florida. Mangrove peat from borings at the mouth of Shark River on the southwest coast. At this locality, the surface of which is covered by high tide, as much as 15 ft of autochthonous mangrove peat overlies a submerged rock surface. Because mangroves do not grow in water depths greater than a few feet, this occurrence of peat indicates rapid relative subsidence, and together with the evidence of still sand or uplift on the southeast coast, suggests a tilting of the Florida peninsula and submarine plateau. The ages also suggest that tropical peats can accumulate very rapidly during subsidence—as much as 1 in. per 20 yr. Submitted by Robert N. Ginsburg, University of Miami.		
Peat at 35- to 50-in. depth.	L-162C	1500 ± 350
Peat at 84- to 94-in. depth.	L-162E	1700 ± 400
II. *Pacific Ocean*		
Rapa Island, South Pacific Ocean. Lignite sample from Rapa Island in the Australian group, Polynesia, assigned a late Tertiary age. The isolation of this lignite and its possible young age were the reasons for the analysis. Submitted by J. M. Schopf, U.S. Geological Survey.	L-150C	> 26,000

Table 3. Radiocarbon dates obtained on archeological samples by the black-carbon method. All ages are given in radiocarbon years before the present.

Description	Sample No.	Age
I. *North America*		
San Francisco Bay, Calif. Samples from burials and midden at University Village site (14-S Ma-77). On the basis of cross-dating with the Early horizon of the Sacramento-Delta region, this site is judged to be the earliest known evidence of human occupation in the San Francisco Bay region. Estimated date 1000 to 2000 B.C. Submitted by B. Gerow, Stanford University.		
Charcoal from burials with major cultural association.	L-187A	2700 ± 350
Charcoal from both burials and midden.	L-187B	3150 ± 300
II. *Asia*		
Saudi Arabia. Three samples of charcoal from an ancient mining site in southwestern Saudi Arabia near the northwestern corner of the Rub al Khali. The ages indicate that the veins were mined for gold during at least two periods and will doubtless be of value for studies of desiccation in the Arabian desert. Samples submitted by W. D. Johnston, Jr., Foreign Geology Branch, U.S. Geological Survey.		
Charcoal.	L-159A	1400 ± 250
Charcoal.	L-159B	550 ± 200
Charcoal.	L-159C	500 ± 250
Baluchistan (Pakistan). The dating of prehistoric Indian and Baluchi chronologies is still in a very early stage because there has been so little evidence for gaging a time datum. It is known that the Harappan cultures of the Indus Valley were flourishing after 2200 B.C. because evidence in Mesopotamian sites of that period has been recovered. The assumption that can then be made is that the pre-Harappan Amri ware can probably be dated in the period between 2800 and 2500 B.C. In Baluchistan the evidence is very scanty, and dating can be made only on the basis of comparison with the Harappan period. The Baluchi sites stand midway between the Indus Valley and Iran, and their dating would be indicative of the period when the Near East was influencing India. A basis for comparison with known Mesopotamian sites is necessary; C^{14} dating of the Quetta sequence makes this possible. The Quetta Valley sequence has been		

Description	Sample No.	Age

worked out by stratigraphic excavation, and five assemblages have been defined, running from a preceramic horizon (Neolithic?) to an elaborate ceremonial and agricultural society. Each of these assemblages contains elements directly comparable to other assemblages known in Baluchistan and the Indus Valley. The preceramic culture (KGM) is of maximum importance because its dating will go far in demonstrating whether the Indian area was so peripheral to Near Eastern culture centers that it has been an area of considerable lag, or whether contacts were more frequent and development was more immediately responsive to the West. On the basis of present-day evidence, the following approximate dates have been postulated for the Indus-Quetta cultures:

Indus Valley	*Quetta Valley*	*Date* (B.C)
Harappan	Damb Sadaat III	2000
	Damb Sadaat II	2300
Amri	Damb Sadaat I	2500–2800
	KGM IV	
	KGM III	3000
	KGM II	
	KGM I	4000

The samples were selected from the stratigraphic levels in the order of sequence from preceramic to the elaborate Quetta culture in order to present a series of sequential dates. The assumption was made that if any sample was contaminated, its date would be out of line with the archeological data. The series of dates resulting is, however, valid in terms of the archeology. If this series of dates can be taken as a reliable indication of the chronology of the Indus River-Baluchistan area, it is clear that, unless considerable cultural lag is postulated, the dates determined by other means for the prehistoric village cultures of both Iran and Iraq to which there is frequent close stylistic comparison with the Baluchistan cultures particularly, must be revised down and in some cases quite considerably.

Charcoal from Kili Ghul Mohammad I site in Quetta Valley, in the base of Room I in the mound. There is no previous date for a preceramic level in the Indian area. The nearest area in which such comparable levels have been dated with reasonable accuracy is in Iraq (Jarmo). In comparison, there appears to be at least a 1000-yr lag in the Quetta area. However, since this sample is taken from the upper levels of the preceramic horizon, it is entirely possible that a date from the lowest levels (3.5 m below) may close the time gap. — L-180A — 5300 ± 500

Charcoal from Mian Ghundai (Damb Sadaat I) Quetta Valley, in rubble fill. The relationships of these levels to the Amri assemblages of Sind are very strong. In view of this fact and of the evidence for dating the Amri of Sind to the period prior to 2300 B.C., and more exactly to 2500 B.C., it appears that the date of 2150 B.C. is too late. In view, however, of the range allowance, it is likely that a date of 2400–2300 B.C. for the Amri of the Quetta Valley (Kechi Beg) is more fitting. — L-180B — 4150 ± 350

Charcoal from Mian Ghundai (Damb Sadaat II) in a hearth from wall C of Room 2. The archeological evidence for contemporaneity of the Quetta culture with the Harappan civilization indicates that this date falls well within the time expectancy of that culture. — L-180C — 4050 ± 400

Charcoal from Mian Ghundai (Damb Sadaat II) from Room 3, north wall complex. This sample belongs to the Quetta culture, as does L-180C. However, it was collected 3 m below L-180C and was separated from it by at least two floor levels. This sample is, therefore, somewhat earlier than L-180C. It is favorable to that of L-180C in stressing the date of 2000 B.C. for the Quetta culture. — L-180E — 4050 ± 350

Hoifung, South China. Charcoal from TAS site in Hong Kong area. This site is believed to belong to the very end of the Neolithic, which is characterized by the first appearance of "glaze" pottery and dark stoneware. The site is thought to be not older than 2000 B.C. or younger than 500 B.C. Submitted by H. L. Movius, Jr., Harvard University; collected by the late Father Maglioni, Catholic Mission, Hong Kong. — L-188C — 2950 ± 400

Hoifung, South China. Shells from coastal Neolithic site in the SOS locality. Sample seems to mark the beginning of "net" decoration, and its typical adzes seem to be ancestors of the rectangular type. Predicted age: between 2500 and 500 B.C. Conch shells growing at present in the area were used as a control. Their activity was 2 percent higher than the average value for modern wood. Collected by the late Father Maglioni and submitted by H. L. Movius, Jr. — L-201A — 3100 ± 150

III. *Europe*

Cave of La Madeleine, near Montpellier (Herault) southern France. Carbonized wheat and shells found between two stratified late Neolithic hearths associated with typical pottery of West European or Chasseyian type. The age was estimated as 2500 to 200 B.C. Collected by J. Arnal, submitted by H. L. Movius, Jr.

Carbonized wheat. — L-188A — 4200 ± 500

Shells (average modern wood value assumed for control). — L-188D — 4700 ± 400

Cave of Suquet-Coucoliere, near Montpellier (Herault), southern France. Samples associated with pottery and artifacts of early Bronze Age type found in level 3 of this site. The overlying horizon yielded materials of the early Middle Bronze Age and late Neolithic material occurred immediately below. The date was estimated as 1900 B.C. The fact that the two C^{14} dates agree indicates that the difference between the predicted and the C^{14} ages is not due to contamination either in the laboratory or in the field. Collected by P. Ponnaux and C. Ponnaux. Submitted by H. L. Movius, Jr.

Charcoal. — L-188B — 1700 ± 300

Wood. — L-188E — 1750 ± 300

Table 4. Radiocarbon dates obtained on geologic samples by the carbon dioxide method. All ages are given in radiocarbon years before the present.

Description	Sample No.	Age
I. *North America*		
A. *Alaska and Canada*		
Umiat, Alaska. Core containing peat and woody material taken in small valley, lat. 69°23'N, long. 152°10'W, 3 mi north of Umiat. Pollen analyses have been correlated with peat from the Chandler Lake area 90 mi to south. Submitted by Boston University Physical Research Laboratories.		
Material 4.2 to 4.6 ft from surface, in layer at top of birch pollen zone.	L-277D	5890 ± 170
Material 20.0 to 21.5 ft from surface, near bottom of birch pollen zone.	L-277C	7530 ± 150
Material 24.0 to 25.0 ft from surface; lies in zone of herbaceous pollen below main peat zone.	L-277B	8300 ± 270
James Bay, Quebec. Peat from bottom level of a bog near Smoky Hills Rapids north of James Bay, 175 ft above sea level. This sample dates the beginning of the upland occupation by forests in this area after recession of the sea. It was previously dated at this laboratory by the black carbon method at 2350 ± 200 yr. Submitted by J. E. Potzger, Butler University, and A. Courtemanche, University of Montreal.	L-219	2430 ± 100
B. *United States*		
Moss Lake, Wash. Samples of sedimentary peat from bog located in S36, T26N, R7E about 3.5 mi east of Stillwater. Submitted by G. B. Rigg and H. R. Gould, University of Washington.		
Peat immediately below layer of white volcanic ash at depth of 14 ft from bog surface.	L-269B	7000 ± 200
Peat immediately overlying blue clay (rock flour) at depth of 21.75 ft below surface.	L-269A	11,900 ± 360
Covington, Wash. Samples of sedimentary peat from bog located about 2 mi east of Covington in S32, T22N, R6E. Submitted by G. B. Rigg and H. R. Gould.		
Peat immediately below layer of brown volcanic ash at a depth of 13.75 ft below bog surface. *Comment*: layer of volcanic ash is presumably correlative with that associated with L-269B.	L-269C	6500 ± 200
Peat immediately above Pleistocene sand and gravel at a depth of 54.5 ft below the bog surface. This sand and gravel is at the bottom of a kettle through which melt water from the Vashon ice sheet passed; it is believed to have been deposited when the front of ice was only a few mi away. If so, the age of this peat should indicate the time that the Vashon ice receded from this area.	L-269D	10,200 ± 500
Santa Rosa Island, Calif. Partially charred and badly decomposed wood sample from base of dwarf mammoth-bearing alluvium in Tecolote Canyon 1 mi inland. This is a minimum date for the 25-ft high sea stand which is probably pre-Wisconsin. Submitted by P. C. Orr, Santa Barbara Museum of Natural History, Santa Barbara, Calif.	L-244	15,820 ± 280
Central California Coast. Rock-boring mollusks that once lived in the surface of a wave-cut platform; this platform, now part of a marine terrace, has an old sea level line which is now approximately 100 ft above sea level at Santa Cruz. Submitted by W. C. Bradley, University of Colorado.	L-285	> 37,000
Mississippi Delta. Wood sample taken from a core at 273-ft depth. Wood from stump of tree that apparently grew on weathered surface which divides Wisconsin and pre-Wisconsin sediments. If this tree grew in place, it must have lived after the sea level was lowered to at least this extent during the onset of the Wisconsin glaciation. This sample was dated earlier (*2*) by the black-carbon method as older than 30,000 yr. Submitted by H. N. Fisk.	L-125I	> 39,000
Wisconsin Lakes. These samples are hydrocarbon extracts from recent sediments in two Wisconsin Lakes. The problem was to define whether these extracts were modern in origin or merely contamination by old hydrocarbons. Sample 243B is the smallest sample which has been subjected to the dating procedure in this laboratory. The total weight of carbon in sample 243B was 0.025 g. Despite the large error, the samples are judged to be composed at least in part of recently formed hydrocarbons. Submitted by S. Judson, Princeton University.		
Lake Mendota bottom sediment 0 to 27 in. depth. Hydrocarbon content about 200 parts per million. Sample run was hydrocarbon extract.	L-243A	5250 ± 1600
Trout Lake bottom sediment 0 to 27 in. depth. Hydrocarbon content about 275 parts per million. Sample run was hydrocarbon extract.	L-243B	1800 ± 1600
South Haven, Mich. Intercalibration samples submitted to various laboratories by J. H. Zumberge of the University of Michigan. The sample consists of a white pine log taken from a peat layer located on the eastern shore of Lake Michigan. Results obtained by the various other laboratories are as follows: Chicago (C-848) 6440 ± 230 yr (*14*); Michigan (M-290) 5090 ± 300 yr (*19*); Yale (Y-169) 5300 ± 250 yr (black carbon) (*19*).	L-214	5130 ± 110
St. Petersburg, Fla. Charcoal (burned long-needle pine) from newly exposed canal cuts near Joe's Creek bridge. Associated with extinct Seminole Field mammals, an "archaic" spear point, flint chips, and burned bone. These materials lie in unconsolidated strata which uncomformably overlie the Pamlico Terrace and therefore are much younger geologically. Nevertheless, the date seems anomalously low in view of the extinct fauna.	L-211	2040 ± 90
II. *Europe*		
Lake Massaciuccoli, Italy. Pebble of compressed peat, perforated by pholads, contained in the purpura haemastoma, s. sp. Consul Beach, at from − 12 to − 26 m of Torre Del Lago. Peat contains the remains of a forest of *Pinus* dominating on *Abies, Picea,* and *Betula,* the highest	L-246	18,350 ± 400

Description	Sample No.	Age
forest formation of the present Alps. Presumably Epi-Wurm II or Epi-Wurm III stage of the last glaciation (*20*). Collected and submitted by A. C. Blanc, Istituto Italiano Di Paleontologia Umana, Rome, Italy.		
III. *Pacific Ocean*		
Raroia Atoll. Samples bearing on eustatic or local fluctuation in the South Pacific Ocean. It is concluded that Raroia coral atoll had attained roughly the present form and dimensions by a date 2500 yr ago. Subsequently, elevation of 15 to 20 cm or eustatic drop in sea level by this amount resulted in onset of considerable erosion of the reef margin by storms and upgrowth of islands by deposition of the coarse rubble of corals. These changes seem to have occurred about 2000 yr ago. Collected by N. Newell, Columbia University.		
Fragment of reef thrown up on erosion remnant of old reef flat, presumably by a hurricane. The date of the limestone of this block provides a rough maximum date by which the atoll had reached its present form and a maximum date for the elevated reef platform on which the block rests.	L-258A	2680 ± 90
Humic soil from a depth of 4 to 5 ft which corresponds closely to the time of change from fine to coarse sedimentation. The sample is thought to be indicative of the maximum age of the principal island of the atoll. This horizon overlies coarse gravel probably equivalent in age to the reef block of sample L-258A.	L-258B	900 ± 130
Pieces of coral separated from the humic soil of sample 258B.	L-258C	1740 ± 230
IV. *Soil studies*		
This group of samples was submitted by the Soil Survey, Soil Conservation Service, U.S. Department of Agriculture, Beltsville, Md. (*21*)		
Podzol from Bennekom, Netherlands (B_{21} horizon, 15 to 20 cm)	L-251A	940 ± 20
Cresco-Kenyon intergrade from Howard County, Iowa, 300 ft west and 150 ft north of SE corner NE1/4 sec. 33, T100N, R13W (A_{11} horizon, 0 to 4 in.).	L-251B	210 ± 130
Cresco-Kenyon intergrade from Howard County, Iowa, 300 ft west and 150 ft north of SE corner NE1/4 sec. 33, T100 N, R13W (A_{12} horizon, 4 to 8 in.).	L-251C	< 100
Edina silt loam, near NW corner, SW1/4 sec. 10, T68N, R21W, Wayne County, Iowa (A_1 horizon, 0 to 6 in.)	L-251D	410 ± 100
Edina silt loam, near NW corner, SW1/4sec. 10, T68N, R21W (A_2 horizon, 8 to 12 in.).	L-251E	840 ± 200
Clarion, A_{11}, 0 to 6 in., Pocahontas County, Iowa.	L-256A	440 ± 120
Webster, A_{11}, 0 to 6 in., Pocahontas County, Iowa.	L-256B	270 ± 120
Barnes loan, 0 to 4 in., Cavalier County, N. D.	L-256D	350 ± 120
Humic Glei, Wayne County, Ind.	L-256C	30,000 ± 8000
V. *Arctic studies*		
Ellesmere Island. Wood samples from shore areas which yield climatological information bearing on the origin and history of arctic ice shelves. The lack of any source area within several hundred miles indicates that the wood probably drifted to its present location on the shore. Samples numbered 254 may indicate times when the shelf was absent; however, a moat between the shelf and the shore has been reported (*22*) that might allow access even during the presence of a shelf. The L-266 series was submitted by Hattersley-Smith; the L-261, L-254, L-248, and L-284 series were submitted by A. P. Crary, Air Force Cambridge Research Center, Cambridge, Mass.		
Wood from hill immediately east of Sanding Lake, Prince Patrick Island. Collected by E. T. Tozer.	L-266A	> 25,000
Wood from 6 mi north of Salmon Point, Intrepid Inlet, Prince Patrick Island. Collected by E. T. Tozer.	L-266B	> 33,000[1]
Wood from top of gravelly ridge about 10 mi inland from Canyon Fiord. Collected by P. F. Bruggeman.	L-266C	> 33,000
Large fragment of spruce believed to be drift wood found near Richardson Depot Point. Collected by A. P. Crary.	L-261A	980 ± 100
Small fragment of spruce from Depot Island in Markham Inlet. Collected by A. P. Crary.	L-261B	2190 ± 150
Small fragments of tamarack from Sheridan River terrace. Collected by A. P. Crary.	L-261C	6050 ± 200
Samples of driftwood from the northern shore of Ellesmere Island behind the present ice shelf. Collected by A. P. Crary.	L-254A L-254B L-254C L-254D	3400 ± 150 5740 ± 200 6120 ± 150 3000 ± 200
	L-248A	7200 ± 200
Ward Hunt Island. Shells from raised beach (140 ft) on Ward Hunt Island, a small piece of land projecting through the ice shelf on the northern shore of Ellesmere Island.		
McClintock Bay. Shells from raised beach near glacier face.	L-248B	7200 ± 200
Ward Hunt Island. Sponges on the surface of ice shelf near west end of island. May have been trapped by sea ice below shelf and subsequently have been brought to surface through melting. Collected by A. P. Crary.	L-284	400 ± 150
T-3 Ice Island. Samples were chosen in order to determine the origins of an 11- by 5-mi ice island floating in the Arctic Ocean. The significance of the dates obtained has been discussed in a separate publication (*22*). Submitted by A. P. Crary.		
Surface dirt in bottom of drainage lake. Represents a combination of all dirt layers with possibility that much of the top material had been washed away.	L-192B	5730 ± 300
Surface grass and debris. Represents top layer in area of much floral material but may not be representative of organic matter in top dirt layer.	L-192E	450 ± 200
Bottom layer of dirt near outcrop. Uncontaminated by surface layer and not subject to drainge loss as was sample L-192B.	L-213D	3050 ± 200

Table 5. Radiocarbon dates obtained on archeological samples by the carbon dioxide method. All ages are given in radiocarbon years before the present.

Description	Sample No.	Age
I. *North America*		
Apponaug, R.I. Oyster shells used as a roof to protect grave food offering by early Indians. Possibly marks the transition between first- and second-period pottery making in New England. Submitted by W. S. Fowler, Narragansett Archeological Society of Rhode Island.	L-270	800 ± 90
Poverty Point, La. This site (NE1/4 of NE1/4 sec. 19, T19N, R10E, West Carrol Parish) represents the end of the Eastern Archaic Stage and the beginning of the Burial Mound Building Stage. It is the same cultural complex as the Jaketown site in Mississippi (*23*) dated by the black-carbon method (*1*) as 2350 ± 200 yr. These archeological sites provide an excellent opportunity for checking the chronology of stream channel positions in the alluvial valley of the Mississippi River which was worked out by H. N. Fisk (*24*). The cultural deposits at Jaketown were made on an island in the active channel of the Ohio River of Fisk's C-1 stage. The Poverty Point village appears to have been established beside the Mississippi River Channel of C-1 stage and the site partially destroyed by an Arkansas River Channel of stage H. Submitted by J. A. Ford, American Museum of Natural History.		
Charcoal from fireplace 18 in below surface in Midden Area, trench A.	L-195	2860 ± 90
Charcoal from extensive layer exposed beneath southern portion of mound B antedating the construction of this part of the mound.	L-272	2660 ± 80
Winnemucca Lake, Nev. Juniper roots and stalks taken from lowest occupation level in wave-cut Fishbone cave 250 ft above the floor of dry Lake Winnemucca, which was once a part of pluvial Lake Lahonton. The climatic conditions in this desert region permitted the preservation of perishable materials not ordinarily found in such old archeological sites. Excellent specimens of basketry, netting, wooden tools, along with bones of horse, camel, and man are found in the lower levels of the cave. Clear evidence of human occupation occurs in the lowest level, which was dated by this sample. The site was occupied by man very shortly after the lake waters fell below the cave floor. Submitted by P. C. Orr, Western Speleological Institute.	L-245	11,200 ± 250
Santa Rosa Island, Calif. Abalone shells taken from upper part of truncated alluvial fan on coast of Santa Rosa Island. Their presence in this type deposit 50 ft above the present sea level indicates that man occupied this alluvial fan during at least the late stages of its formation. Submitted by P. C. Orr, Santa Barbara Museum of Natural History, Santa Barbara, Calif.	L-257	6820 ± 160
II. *South America*		
Nazca, Peru. Key horizons from ancient Nazca sites collected in 1952–53 (*25*). Submitted by W. D. Strong, Columbia University.		
Site N-1 (Estaqueria)—Strata Cut I (catalog No. 134) from burned end of stake at 0.65-m level; charcoal. Huaca del Loro phase, Fusional Epoch.	L-268E	900 ± 70
Site NTu-8 (Huaca del Loro); Temple Fill from first floor of round temple structure (catalog No. 104); charcoal. Huaca del Loro phase, Fusional Epoch.	L-268F	970 ± 70
Site NTu-8 (Huaca del Loro); Whale Bone Room (catalog No. 103); charcoal. Huaca del Loro phase, Fusional Epoch.	L-268G	1200 ± 80
Section of post removed from small mound at the intersection of lines in the San Jose Pampa; wood. Middle Nazca phase, Florescent Epoch.	L-268H	1430 ± 80
Site N-4 (Cahuachi); Strata Cut I-SW, 3.00- to 3.25-m level (catalog No. 192) from fireplace in southwest face of cut); charcoal. Proto-Nazca phase, Formative Epoch 1.	L-268C	1460 ± 80
Site N-4 (Cahuachi); Strata Cut 7, 4.00- to 4.25-m level (catalog No. 311); charcoal. Proto-Nazca phase, Formative Epoch.	L-268D	1630 ± 80
Site N-4 (Cahuachi); Strata Cut I, 3.50- to 3.75-m level (catalog No. 139); charcoal. Late Paracas phase, Formative Epoch.	L-268A	1710 ± 80
Site N-4 (Cahuachi); Strata Cut I, 3.75- to 4.00-m level (catalog No. 140); charcoal. Late Paracas phase, Formative Epoch.	L-268B	1840 ± 80
Paracas, Peru. Prehistoric cotton cloth, mummy 114 (Bundle B 1946–14, American Museum of Natural History) Paracas Necropolis Period, Peru. This specimen is of the same age as Libby's sample 271 (*14*) which gave 2257 ± 200 yr. Previously dated at Lamont by black-carbon method as 1700 ± 200 yr. (*1*). This figure would place the Necropolis phase of Paracas as contemporary with such important ceramic types as W. D. Strong's incised, slip-painted early Nazca and the Cavernas negative ware. Neither of these has been reported from Necropolis graves. Although perplexing, this observation does not rule out the acceptance of the 1750 ± 100 yr figure, and by some would be taken as supporting evidence. Submitted by Junius Bird, American Museum of Natural History.	L-115	1750 ± 90
Huaca Prieta, Chicama Valley, Peru. Charcoal from two separate samples of firepit at bottom of Test 2, the oldest surviving portion of this midden. Its age should indicate the start of the preceramic, agricultural culture which ultimately produced this midden. Previously dated by the black-carbon method at the Lamont Observatory at 3650 ± 400 yr and by the University of Chicago (sample C-598, at 4298 ± 230 yr (*14*). Collected by C. Larco; submitted by Junius Bird.		
Charcoal.	L-116A	3780 ± 100
Charcoal.	L-116B	3860 ± 100

Description	Sample No.	Age
Amazon Basin. These samples represent an attempt to date pottery from the small organic content which is present in the binding material. The prehistoric ceramics in the Amazon basin were made with the aid of burned bark of the Caraipe tree and/or fresh water sponges as tempering agent. The samples were gathered in two sites of so-called "black earth" on the floodplain at the confluence of Negro and Solimoes (Amazon) rivers in the upper layer (30-cm depth). In addition to defining an age for the ceramics, the samples would date the minimum time since the alluvial deposits were layed down by the Parana do Careiro as it shifted to its present course. This knowledge is of practical value in assessing the degree of permanency of the alluvial stream pattern downstream from Manaus. The dates were calculated on the basis of the assumption that the organic matter was dominantly plant matter, probably caraipe bark, although there was evidence of sponge spicules. The organic matter from living sponges in the same area give a specific activity only 70 percent of that of normal modern wood. Thus the ages are maximal and would be lowered in proportion to the ratio of sponge-plant contribution to the tempering material. The samples were collected by H. O'Reilly Sternberg, Centro de Pesquisas de Geografia do Brasil, who, in the course of his investigation of the geomorphology of this area, conceived the idea of using the tempering agent of the sherds as a carbon source. The project was supported by a grant from the Conselho Nacional de Pesquisas, of Brazil.		
Rims and decorated sherds from Fazenda "Bom Successo."	L-198A	2050 ± 120
Sherds from Fazenda "Alencorne."	L-198C	1100 ± 130
III. *Asia*		
Hotu Man, Iran. Charcoal from hearth under and associated with Hotu skeletons No. 2 and No. 3. The University of Pennsylvania laboratory obtained an age of 9190 ± 590 yr on same material by black-carbon method (*26*). Submitted by C. S. Coon, University of Pennsylvania.	L-182	9500 ± 200
IV. *Africa*		
Khanguet-el-Mouhaad (Department of Constantine), Algeria. This site is important in that it is the first Upper Capsian site in which human remains have been found to be dated by the C^{14} method. The burial is being studied by L. Cabot Briggs at the Bardo Museum in Algiers. Charcoal was found associated with the skeleton at depth of 90 to 100 cm below the surface of midden deposit. Collected by M. Jean Morel of Bone. Submitted by H. L. Movius, Jr.	L-240B	7200 ± 230
Kalambo Falls, Northern Rhodesia. Wood from tree trunk found in Lower Paleolithic site. Presumably this horizon belongs to the very end of the third Interpluvial (Kanjeran-Gamblian) or the very beginning of the Gamblian Pluvial Period—that is, of third interglacial or early fourth glacial age. Excavated by J. D. Clark, Rhodes-Livingstone Museum, Livingstone, Northern Rhodesia. Submitted by H. L. Movius, Jr.	L-271A	> 35,000
Florisbad, near Bloemfontein, Orange Free State. The Florisbad Skull (*Homo* or *Africanthropus helmei*) was discovered in association with many stone implements and fossil bones of numerous extinct species of animals in the lowest of three peat layers at this site. Samples from the three layers were measured by Libby (*14*), who obtained the following ages: (i) sample C-850, Peat layer No. I, older than 41,000 yr; sample C-851 Peat layer No. II, 9104 ± 420 yr; sample C-852 Peat layer No. III, 6700 ± 500 yr. A. C. Hoffman, director of the National Museum in Bloemfontein, who collected these samples, felt that the date for the middle peat (Peat II; sample L-271-C) was definitely too low, since remains of extinct animals were found in association with it. Further investigation revealed that this layer had been penetrated by the roots of gum trees, and, accordingly, a whole new set of carefully collected and cleaned specimens was chosen. Submitted by H. L. Movius, Jr.		
Peat layer No. I	L-271B	> 35,000
Peat layer No. II	L-271C	28,450 ± 2200
Peat layer No. III	L-271D	19,530 ± 650
V. *Pacific Ocean*		
Masbate Island, Philippines. Charcoal from depth of 12 to 18 in. in a "late Neolithic" dry cave site. Date tests H. O. Beyer's prehistoric sequence for Northern Malaysia. Collected by W. G. Solheim, II, University of Arizona. Submitted by H. C. Conklin, Columbia University.	L-274	2710 ± 100
Murray Valley, South Australia. These two samples provide the basis for the archeological sequence in all of Australia. Shells of living mollusks collected in the Tartanga Lagoon on the Murray River were used as modern control for these samples and were found to be approximately 1 percent greater than our modern wood standard. Collected by N. B. Tindale, South Australian Museum, Adelaide. Submitted by H. L. Movius, Jr.		
Large *Unio protovittatus* shells from Layer C at the Tartanga site referred to as Mid-Recent and believed to have been occupied prior to the deposition of the 10-ft terrace of the River Murray. Possibly as old as 9000 yr. Layer C represents approximately the midpoint in the sequence at this site. Tindale estimates that the earliest occupation (Layer A) may go back as a minimum to 8000 years before the present.	L-271E	6030 ± 120
Shells from Layer IX at Devon Downs which provide a figure for the middle stage in the development of the Pirrian culture, of which Devon Downs is the type site. There is no geologic basis for dating this horizon, although it is believed to be younger than the time of formation of the 10-ft terrace of the Murray and hence as old as 4500 years before the present. In any case, at the time Devon Downs was occupied, the climate in South Australia was definitely more moist than it is at present.	L-271G	4290 ± 140

Table 6. Radiocarbon dates obtained on Atlantic deep-sea cores by the carbon dioxide method. All ages are given in radiocarbon years before the present.

Description	Sample No.	Age
Core A-180-74. Collected from 3330-m depth at lat. 0°03′S; long. 24°10′W. Core consisted of uniform foraminiferal lutite with no obvious evidence of turbidity currents, erosion, slumping, or reworked older sediments. The excellent agreement in lithology between this core and three others taken on a 400-km traverse across the mid-Atlantic ridge in the equatorial region indicates that this core represents an undisturbed and uninterrupted record of sedimentation.		
Depth 0 to 5 cm	L-295A	3630 ± 170
Depth 18 to 21 cm	L-295B	11,260 ± 460
Depth 38 to 41 cm	L-295C	15,000 ± 500
Depth 57 to 64 cm	L-295D	18,910 ± 680
Depth 77 to 83 cm	L-295E	23,000 ± 1100
Depth 97 to 103 cm	L-295F	26,700 ± 1800
Depth 114 to 125 cm	L-295G	37,500 ± 4000
Core R10-10. Collected from 4755-m depth at lat. 41°24′N, long. 40°06′W. Core consisted of lutite taken from basin east of the Mid-Ocean Canyon in Newfoundland Basin. The lower part of the core contains some glacial marine deposits. The date of the material in the first 7 cm in the core is somewhat older than expected. Whether this is due to mixing of the top of the core in collection, inclusion of carbonate from preexisting sediments, or loss of the top of the core in collection is not clear.		
Depth 0 to 7 cm	L-212G	4160 ± 190
Depth 35 to 39 cm	L-212H	4360 ± 200
Depth 60 to 70 cm	L-202	8100 ± 120
Depth 90 to 100 cm	L-212A	10,680 ± 180
Depth 112 to 120 cm	L-212C	10,550 ± 420
Depth 120 to 125 cm	L-212D	11,800 ± 480
Depth 165 to 175 cm	L-212F	15,820 ± 600
Depth 255 to 275 cm	L-212E	20,300 ± 900
Core A179-8. Taken at 4060-m depth at lat. 20°28′N, long. 72°49′W, northwest of the Island of Hispaniola on the Caicos-Hispaniola abyssal plain. The core contains numerous layers of calcareous sand probably due to slumping or turbidity currents. The normal sediment consists of lutite.		
Depth 218 to 228 cm	L-279A	10,860 ± 180
Core A179-15. Taken at 3110-m depth at lat. 24°48′N, long. 75°55′W off Eleuthera Island, Bahamas, from a steep slope. Core consisted mainly of calcilutite with a layer of calcareous silt near the base of the section.		
Depth 94 to 99 cm	L-279B	7600 ± 130
Depth 110 to 113 cm	L-279E	10,700 ± 480
Core A180-48. Taken from Fosse de Cayar submarine canyon in the continental shelf near Dakar, French West Africa, at a depth of 1450 m at lat. 15°19′N, long. 18°06′W. The core was taken from canyon wall 100 fathoms above the canyon floor. Material consists of dark green clay very uniform throughout except for silt partings and lenses.		
Depth 190 to 210 cm	L-294B	10,480 ± 380
Depth 440 to 455 cm	L-279D	11,380 ± 390
Depth 490 to 510 cm	L-294C	15,300 ± 550
Core A164-62. Taken at lat. 39°45′N, long. 68°53′W at 2270-m depth. The upper 250 cm of the core consists of graded micaceous glauconitic gray sand. Below the sand, the deposition appears to be normal and the purpose of the measurement was to determine the extent of erosion at the time of sand deposition. The date indicates that at most, only a small amount of post-Wisconsin sediment was removed.		
Depth 468 to 488 cm	L-279C	6990 ± 140
Core A180-1. Taken at 5120-m depth at lat. 39°07′N, long. 54°32′W. The upper 130 cm of the core consists of sands that were probably deposited by the Grand Bank's earthquake turbidity current of 1929 (*27, 28*). The age of 5200 yr indicates that there was only limited erosion at the time of the sand deposition and confirms recency of the event.		
Depth 140 to 170 cm	L-212B	5130 ± 130

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A man who has committed a mistake and doesn't correct it is committing another mistake.—CONFUCIUS.

Hans Geiger

Fiftieth Anniversary of the Publication of His Doctoral Thesis, 23 July 1906

Divine curiosity and a childlike impetus to play are, Einstein told us, the driving forces of the true investigator. If any scientist fills this definition, he is Hans Wilhelm Geiger, with his desire to explore the unknown and his enjoyment of the ingenious devices of his own design. Those who were fortunate enough to witness one of Geiger's presentations of a problem in modern physics will never forget the grandeur of the performance. They will recall Geiger's pleasure, pride, and happiness when, with the counter clicking, he would convince his audience of the transmutation of the atom, and of the existence of a world beyond that revealed to the unaided senses. This world fascinated Geiger and inspired him in his efforts to create and to be understood.

Geiger was born on 30 September, 1882, in Neustadt in der Rhein-Pfalz, one of Germany's loveliest wine districts. His great achievements are the Geiger-Nuttall relation, Geiger point counter, Geiger-Mueller counter, and the coincidence principle. The trend of Geiger's contribution is revealed in his thesis on "Strahlungs-, Temperatur- und Potentialmessungen in Entladungsröhren bei starken Strömen," which was directed by Professor Wiedemann and presented on 23 July 1906 to the Philosophical Faculty of the Friedrich-Alexanders-University at Erlangen, Bavaria.

On first inspection, Geiger's thesis appears similar to the other dissertations produced at that time. It is classical in form and arrangement, with the customary dedication to "My beloved parents." However, a closer look reveals an unusual talent for observation, a skill in arranging experiments, and the ability to think and write clearly. Geiger's problem originated in the studies of one of the professors of the Physics Institute, A. Wehnelt, who discovered the Wehnelt cathode. The problem involved experiments with and measurements of electric discharges in vacuum tubes, and it served to make Geiger familiar with a technique so fundamental to his later discoveries.

The years 1906–1912 Geiger spent in England with Ernest Rutherford, exploring and investigating the fundamentals of radioactivity. Soon he became known by his valuable contributions to the new field, and in 1912 he was appointed head of the new Laboratory for Radioactivity of the Physikalisch-Technische Reichsanstalt (PTR) in Berlin. Here, in 1913, Geiger selected W. Bothe as his coworker, and years of extremely successful teamwork began. The outstanding experiment of the years at the PTR was the confirmation of the Compton effect in 1925, using two Geiger point counters in coincidence for the simultaneous detection of the scattered quantum and of the recoil electron.

H. Geiger

[Courtesy *Die Naturwissenschaften*]

In 1925 Geiger accepted the chair of physics at the University of Kiel, specializing in the development of new counting devices, while Bothe concentrated on the development and application of the coincidence method. In 1928 the first publication on a new counting device, later called the Geiger-Mueller counter, appeared in the *Physikalische Zeitschrift*, opening a wealth of stimulation and progress in nuclear research. Many studies and many applications of the counter have been reported since 1928. In research as well as in industry, the counter has proved its versatility in many situations and, only to mention briefly, it was a photon Geiger tube that was used as detector in the first automatic scintillation counter device. Of course it was a long way from the first counter to the modern equipment as available as amperemeters and voltmeters on the market today.

In 1936 Geiger moved to Berlin-Charlottenburg as chief of the physics department of the Technical University. Despite the many administrative and teaching obligations connected with this position, he found time for research in cosmic-radiation physics, artificial radioactivity, and uranium fission. The editorship of the Journal *Zeitschrift für Physik* and plans for a new edition of the *Handbuch der Physik* occupied him mostly, when in 1940 a painful rheumatic condition confined him to bed, with a stiff body, for years. Improvements in his condition early in 1945 could not help him very much, for in June 1945 his home near Babelsberg was occupied. He lost all his possessions and was just fortunate enough to find a primitive dwelling place near Potsdam. Here he died on 24 September, 1945—his weakened health being unable to stand any longer the many physical and emotional stresses of the chaotic times.

No high honors and no decorations were bestowed on Geiger during his lifetime. It is the impact of his discoveries that has made him known all over the world. Today he is celebrated as one of the outstanding pioneers of the atomic age.

A. T. Krebs
U.S. Army Medical Research Laboratory, Fort Knox, Kentucky

If some great power would agree to make me always think what is true and do what is right, on condition of being turned into a sort of clock and wound up every morning before I got out of bed, I should instantly close with the offer.—Thomas Henry Huxley, *Materialism and Idealism.*

News of Science

Retia Mirabilia of Cetaceans

The typical vascular pattern of the mammalian body comprises a single artery accompanied by one or two veins. In the extremities of lorisine lemurs, some edentates (sloths, certain anteaters, and pangolin), and Sirenia, this simple pattern is replaced by a "blood-vascular bundle." This bundle is a specialized and complex sort of *rete mirabile* consisting of numerous small arteries and veins surrounded by a connective-tissue sheath. The function of such a bundle has long been a mystery. Among terrestrial mammals, it attains its highest development in slow-moving forms and, hence, has been interpreted as a specialization correlated with sluggishness. This explanation, however, does not explain its presence in aquatic mammals.

Similar, although not identical, multichanneled arteriovenous bundles are found in the fins and flukes of whales. These have been studied by Scholander and Schevill [*J. Applied Physiol.* **8**, 279 (Nov. 1955)]. Each major artery is surrounded by a multiple thin-walled, trabeculate venous channel, resulting in two concentric conduits, the warm one being inside. In addition, there are separate superficial veins with thicker walls. On the basis of the anatomical findings and perfusion experiments, the authors conclude that these blood-vascular bundles are concerned with heat preservation. In such a countercurrent system, the warm arterial blood is cooled by the venous blood already chilled in the fin. Thus the heat of the arterial blood does not reach the fin but is short-circuited back into the body via the venous system. Body heat is therefore conserved at the expense of keeping the appendage cold. The efficiency of heat exchange in a system of this sort is related to speed of blood flow. The slower the flow, the more efficient the heat conservation. On the other hand, cooling of the fin during exercise in relatively warm water could theoretically be accomplished by rapid flow of blood into the appendage. Temperature measurements taken on porpoises support the concept that there is heat regulation in the fins.

The authors interpret the analogous blood-vascular bundles in the limbs of sloths as serving a similar function, since these extremely sluggish animals can barely keep warm even in their warm environment. One wonders whether the same reasoning can be applied to the bundles of the slow lemurs—which apparently are more active than the sloths—and of the pangolin—which is not an exceptionally sluggish animal.—W. L. S., JR.

Peace Pills

Within the last 4 years, tranquilizing drugs have come into wide use for relief from daily tensions and from the special demands of business or professional life. Unlike sedatives, the tranquilizers are supposed to reduce anxiety without loss of alertness. The American Psychiatric Association, although recognizing the legitimate use of such drugs in the psychiatric treatment of certain classes of patients, has taken a stand against their casual use in a statement mailed to its 9353 members.

Something like 35 million prescriptions for the drugs will be written in 1956, according to the APA. The association also cites a recent estimate that among the first ten compounds most frequently prescribed in 1955, three were tranquilizers. The statement issued by the APA said that it was important to obtain scientific data about drugs and warned that the treatment of emotional illness with the tranquilizing drugs involves the obligation of close supervision by a physician familiar with this specialty.

Psychiatrists are not the only scientists investigating the effects of the new drugs on emotional behavior. In a recent effort to use laboratory methods to gain more of the needed data, Joseph V. Brady [*Science* **123**, 1033 (8 June 1956)] demonstrated that rats and monkeys under the influence of reserpine will continue to gain rewards by pressing bars during short periods of "emotional stress." Even with this advantage, however, the total number of lever responses for a longer period—one that includes shorter periods of stress—is less than the number achieved by saline control animals, whose responses are momentarily depressed during the shorter periods.

Genetics of the Leopard Frog

When one considers the widespread use of the common leopard frog, *Rana pipiens,* in elementary laboratory study in biology, it is indeed surprising that so little is known about its genetics. Now Peter Volpe [*J. Heredity* (Mar.-Apr. 1956)] has presented the results of some analyses of great interest. The nonspotted variety of leopard frog found in certain populations has been known since 1942 to be a simple Mendelian dominant to the common spotted pattern. A mottled variety found in southwestern Minnesota has been shown by Volpe to be also a simple Mendelian dominant. When the two mutant varieties were crossed in either direction, Volpe obtained 2 mottled : 1 nonspotted : 1 spotted. A complete analysis can be made only if the hybrids can be reared to sexual maturity and backcrossed to the common spotted form; but it seems likely that the three varieties depend on a series of multiple alleles, C^K (mottled) being dominant over C^B (nonspotted), and both of the foregoing alleles being dominant over c (spotted).

The difficulty is that of rearing the frogs in the laboratory from the stage of metamorphosis to that of sexual maturity. It would be interesting to see whether tagged or marked hybrids could be released into one or more ponds containing only the *pipiens* form and could then be recaptured for genetic testing after 2 or 3 years. The experiment might also throw interesting light on some important problems of population genetics; for example, what happens in a population of a given size when one or the other of the mutants is introduced at a specific frequency? Will the fate of the seeded mutant be the same at different levels of seeding and in different sizes of populations? Will the fate be the same in ponds within the natural distribution of the mutant form as in ponds outside of the natural distribution? Will a pond seeded with both the mottled and the nonspotted forms show a superior advantage of either one in competition with the normal spotted variety? Many problems of evolutionary, as well as genetical, interest may be attacked by turning the laboratory out of doors, so to speak.—B. G.

Polio Vaccine Available

The release of a total of 17,172,396 cubic centimeters of poliomyelitis vaccine during June—almost twice as much as was ever before released in a single month—was announced recently by the U.S. Public Health Service. Altogether, 79,058,460 cubic centimeters have been released to date. Commenting on the record production in June, Marion B.

Folsom, Secretary of Health, Education, and Welfare, said:

"I am advised that there are 53 million persons in the top priority group of children under 15 and expectant mothers. Enough vaccine has now been released to provide two injections for three-fourths of this group.

"The period of acute shortage of vaccine now appears to be over in many parts of the nation. In areas where demand still exceeds supply, we may look forward to an easing of the shortage soon if production continues at the present rate.

"I urge parents, physicians, and health officials to cooperate in making maximum use of the increasing supply of vaccine as it becomes available. We should all remember that vaccination in July may prevent polio in August or September—the months when the danger is greatest."

Altogether, states and territories have now been allotted 64,747,305 cubic centimeters; the National Foundation for Infantile Paralysis has received 13,732,134 cubic centimeters; 16,281 cubic centimeters have been licensed for export; and 562,740 cubic centimeters went into commercial channels before controls were established.

Scientists Serve High Schools

In order to determine what efforts are being made by science departments and scientists to maintain specific contact with potential science students, the AAAS Science Teaching Improvement Program (STIP) sent a questionnaire to 809 4-year colleges. A total of 733 replies have been received for a 90-percent return.

The most common method for providing contact between the high-school student and the scientist is on the college campus. Career days are sponsored by 374 colleges as one way to enable students to understand science and scientists. Engineering and/or science expositions are held by 174 colleges. Mathematics or science assemblies are convened by 102 colleges. The assembly programs may be provided by students but commonly involve senior scientists. Science fairs are sponsored by 235 colleges in cooperation with Science Clubs of America, the State Academies of Science, and/or other groups.

Less commonly the approach is of a more individual nature and usually for a longer time. Thirty-eight of the colleges hold workshops for high-school students. These may be held after the junior or the senior year of high school. Fifteen of the colleges give tests for high-school students to aid in the selection of the major field by the student and to give both the student and his counselors some idea of his chances of success in his chosen field.

Direct contact between the scientist and the student is helpful in dispelling a common notion that scientists are "peculiar." One of the most significant findings of the survey was that scientists are active in student guidance at 423 of the colleges.—I. E. WALLEN

Placebos versus Reserpine

Blank placebo pills had the same effect as reserpine, a tranquilizing drug, when they were used to relieve anxiety of patients before surgery, it was reported by three Northwestern University doctors, Roy M. Whitman, assistant professor of neurology and psychiatry, Morris A. Lipton, assistant professor of medicine, and Eva Kavan, former instructor in surgery.

In a "double blind" study with 30 patients, one group received the placebos and the other received reserpine, also called rauwiloid, for 6 days before surgery. About one-half of both groups showed " a significant change in anxiety," whether they received the drug or blank pill, the report said. The pills were identical in appearance, and "neither the doctor, nurse, anesthesiologist, nor patient knew which pill was the real thing."

The study was part of a search to find more satisfactory drugs for use before operations being performed in the Veterans Administration Research hospital at the Northwestern medical center. The report was made in the summer issue of the *Quarterly Bulletin* of Northwestern University Medical School.

News Briefs

■ On the Ishibashi brothers' ranch in Torrance, Calif., plastic film spread on the ground to keep strawberries from touching the moist soil and to prevent the soil from drying out has reduced fruit losses resulting from mold rot by 75 to 85 percent. The Ishibashis felt that plastics might succeed where other types of mulches were prohivitively expensive or did not last long enough. The plastic film, which is specially perforated for this job, is made from Bakelite polyethylene, a product familiar to growers and consumers alike as a material for packaging fruits and vegetables.

■ According to a recent report in the July issue of *Medical Times* by Paul Williamson of Albuquerque, N.M., a newly developed polyethelene tape is superior to suturing in closing wounds. The advantages described are improvement in the rate of wound healing and reduction in the incidence of infection and scarring. Application of the tape is described as painless, and the tape usually may be freely removed when healing is complete.

■ In an amendment approved 4 June to the U.S. Information and Educational Exchange Act of 1948, Congress ruled that exchange visitors in this country under provisions of the act may not apply for either an immigrant or nonimmigrant visa or for status as an alien admitted for permanent residence until 2 years have elapsed following their departure from the United States. However, the attorney general, if he finds it in the public interest, may waive this requirement on the request of an interested Government agency and the recommendation of the Secretary of State. The title of the U.S. Information and Educational Exchange Act of 1948 reads "An Act to promote the better understanding of the United States among the peoples of the world and to strengthen cooperative international relations."

■ A group of four Stanford Research Institute industrial economists headed by Raymond H. Ewell will aid India in the development of small industries as a part of India's second 5-year plan. The project is being carried out under a contract between the institute and the Indian Department of Commerce and Industry.

■ A step toward meeting the long-felt need for a properly housed National Library of Medicine [*Science* **123**, 869 (18 May 1956)] was taken by the Senate on 11 June, when it passed bill S. 3430 as amended. The bill provides for the establishment of a National Library of Medicine in the U.S. Public Health Service, under the supervision of a 17-member board, and authorizes construction of a new building for the library in or near the District of Columbia. The identical bill introduced in the House, H.R. 11524, has been approved by the Subcommittee on Health and Science of the House Interstate and Foreign Commerce Committee and has been sent to the full committee for further action.

■ A new large-diameter deep-sea corer has been developed by Maurice Ewing, professor of geology at Columbia University and director of the Lamont Geological Observatory at Palisades, N.Y. The new instrument has a diameter of 11.5 inches and will penetrate about a foot of the ocean floor. The large sample thus obtained can be subjected to more precise analysis than the cores obtained by the smaller instruments previously available. The corer has been tested in the Hudson River and in 13,000 feet of water off the Canary Islands and is at present being used in the Mediterranean. The

samples obtained will, upon analysis, give information about the concentration of such trace elements as copper, lead, nickel, zinc, and chromium in deep-sea muds as well as material for radiocarbon dating and for study of the bottom-dwelling fauna.

■ A patent has recently been issued to Donald F. Jones, Connecticut Agricultural Experiment Station, and Paul C. Mangelsdorf, Harvard University, for a genetic process that eliminates or greatly reduces hand removal of tassels in the production of hybrid seed corn. In the hand process, which at the peak of the season requires the labor of more than 125,000 people, tassels are removed from the seed-producing corn in order to assure pollination from another inbred line of corn in adjacent fields.

In the genetic process, the seed-producing line of corn has bred into it a cytoplasmic gene for male sterility. Accordingly, it does not produce pollen and does not have to have its tassels removed. To produce double-cross hybrid seed, the process is more complicated. Hand removal of tassels may be used at one stage, or a dominant gene for restoration of male fertility may be introduced into one of the stocks to be crossed to the product of the first male-sterile cross.

The patent, thought to be the first in the United States for the control of an industrial process by genetic means, has been assigned to the Research Corporation, a non-profit foundation that administers patents that originate in college or university research. The foundation disburses the royalties from its patents in the form of research grants.

■ Experiments by the U.S. Department of Agriculture on the control of sagebrush by the herbicide 2,4-D have been carried on for the past 10 years on range lands in the Lassen and Modoc National Forests of northern California. The sprays could be effectively applied by ground rig, airplane, or helicopter. Where sagebrush was sparse, application of 2,4-D was more economical than plowing or burning. Following treatment, kill of sagebrush in large-scale tests ranged from 88.5 percent to 99 percent. With deferment of grazing for 1 year and good grazing management thereafter, native grasses and reseeded species will become established, and the return of sagebrush will be delayed.

■ The National Geographic Society-*Calypso* expedition will try to obtain photographs from the deepest levels ever attained at two sites: in the deep of about 18,500 feet 350 miles off the Liberian coast, and in the Romanche trench, which lies some 500 miles west of the first site and reaches a depth of about 25,000 feet. The society has sponsored the work of the French oceanographic vessel, the *Calypso,* captained by Jacques-Yves Costeau, for the past 4 years. In the present expedition, a new 100-pound camera invented by Harold E. Edgerton of Massachusetts Institute of Technology will be lowered on a 0.25-inch nylon line 28,000 feet long. The camera is equipped with electric lights and a position indicator that will determine distance from the bottom by reflected sound waves.

Scientists in the News

LEONARD M. GOLDMAN, nuclear physicist and for the past 4 years a member of the staff at Princeton University, has been appointed research associate at the General Eelectric Research Laboratory, Schenectady, N. Y.

MARSHALL W. JENNISON, professor of bacteriology in the department of plant sciences at Syracuse University, has been named chairman of that department.

GORDON E. GIBBS has been appointed professor and chairman of the department of pediatrics at the University of Nebraska College of Medicine. His special interests are in cystic fibrosis of the pancreas, juvenile diabetes, pediatric gastroenterology, and pediatric endocrinology and metabolic diseases.

MILTON LEVY has been appointed chairman of the department of biochemistry and CHESTER W. HAMPEL has been appointed chairman of the department of physiology and biophysics at New York University.

MERL M. MUSSELMAN has been appointed chairman of the department of surgery at the University of Nebraska College of Medicine.

ARNOLD COURT, former chief climatologist of the Office of the Quartermaster General, Department of the Army, has joined the staff of the California Forest and Range Experiment Station of the U.S. Forest Service in Berkeley, Calif., as meteorological adviser. He will participate in a new 5-year cooperative research project that is being carried out by the Forest Service and the state of California to determine how timber in the Sierra Nevada should be harvested to provide the best possible yield of water from the winter snow pack.

RICHARD W. WALLEN, associate professor of psychology at Western Reserve University, has accepted appointment as senior associate for Creelman Associates, Cleveland, Ohio, consultants in the management sciences.

ROBERT GLASER, former program director at the American Institute for Research, Pittsburgh, has been appointed associate professor of psychology at the University of Pittsburgh.

WILLIAM S. BENNINGHOFF, chief of the U.S. Geological Survey's Alaska Terrain and Permafrost Section, has been appointed associate professor of botany to head the program of ecology at the University of Michigan's department of botany. He succeeds PIERRE DANSEREAU, who is now dean of faculties at the University of Montreal.

MARTIN L. STONE has been appointed professor and director of the department of obstetrics and gynecology at New York Medical College, where he has been a faculty member since 1949.

JOHN OSBORNE, professor of prosthetics at the University of Birmingham, England, has been named visiting professor of dental materials at Northwestern University Dental School.

Recent Deaths

GEORGE P. DIXON, Alexandria, Va.; 67; communications engineer; executive vice president of the Armed Forces Communications and Electronics Association; 9 July.

HARRY J. EPSTEIN, Philadelphia, Pa.; 54; associate professor of medicine at Hahnemann Medical College; 9 July.

EARL H. MORRIS, Boulder, Colo.; 66; research associate in archeology for the Carnegie Institution of Washington since 1924; lecturer in anthropology at the University of Colorado; 24 June.

WILLIAM WELKER, Oak Park, Ill.; 75; retired head of the biochemistry department of the University of Illinois College of Medicine; 7 July.

Education

■ A new national organization will seek more effective training for teachers and students in basic subjects, especially English, mathematics, science, history, and foreign languages. Incorporated in the District of Columbia, the group will be known as the Council for Basic Education.

Starting with a nation-wide membership of 110 prominent laymen, educators, editors, writers, and industrialists, the council plans to expand its individual

membership as soon as its Washington headquarters can be established. It will also enlist the support and cooperation of educational, professional, and citizens' organizations that are concerned with the vital problems of education. At present CBE's activities are being financed by a generous grant from one of the private foundations.

The officers are president, Arthur Bestor, professor of history, University of Illinois; vice president, Paxton Blair, a former New York Supreme Court justice; treasurer, Howard A. Meyerhoff, executive director, Scientific Manpower Commission; and executive secretary for 1 year, Harold L. Clapp, who will be on leave of absence from his duties as professor of Romance languages at Grinnell College.

■ Colorado College is the 24th liberal arts college to join Carnegie Institute of Technology in a 5-year undergraduate program. At the end of 3 years of liberal arts at Colorado College, with a major in science, and 2 years of engineering or science at Carnegie Tech, students will receive a bachelor of arts degree from Colorado College and a bachelor of science degree from Carnegie Tech.

■ The council on postgraduate medical education of the American College of Chest Physicians will sponsor postgraduate courses this fall in Chicago and New York on recent advances in the diagnosis and treatment of chest diseases. For information write to the Executive Director, American College of Chest Physicians, 112 E. Chestnut St., Chicago 11, Ill.

■ Courses for about 60 high-school science teachers will be offered this summer at the University of New Mexico, at Harvard University, and at Duke University under a program jointly supported by the U.S. Atomic Energy Commission and the National Science Foundation. Lasting 6 to 8 weeks, the courses will include lectures and laboratory work in radiobiology as well as refresher courses in physics, mathematics, biology, and other sciences. Upon completion of the summer's work, each teacher will receive a kit containing radiation measurement instruments and other apparatus, so that by conducting classroom demonstrations he can stimulate interest in atomic energy.

The courses are offered without cost to the teacher-students and include a small allowance for living expenses that was made possible by NSF support. The AEC will supply the necessary laboratory equipment and defray certain teaching costs. The three universities will provide a full-time faculty and classroom space and will also arrange for guest lecturers.

Grants, Fellowships, and Awards

■ The National Science Foundation is accepting through *4 Sept.* applications for a second group of postdoctoral fellowships in the life and physical sciences and in the fields of convergence between natural and social sciences. Winners will be announced on 16 Oct. 1956. These fellowships are in addition to the second group of awards planned under the Senior Postdoctoral Program, which was announced earlier [*Science* **123**, 1115 (22 June 1956)].

Decision to award the postdoctoral fellowships for a second time during the current year was made in order to permit those who completed academic requirements since March 1956, when the last group of fellowships was awarded, to begin postdoctoral studies earlier than would otherwise be possible. Applications are not restricted to those who received their Ph.D. degrees in June, however.

Candidates must be United States citizens who will begin or continue studies at the postdoctoral level at any time within 1 year after announcement of awards. In most cases individuals who receive fellowships will begin their fellowship activities within 9 months after the award date. Selection will be made solely on the basis of ability and will be based on academic records, written evaluation of each individual by faculty advisers or other qualified observers, and a proposed plan of research. Applicants will be rated by special fellowship panels established by the National Academy of Sciences. Final selection will be made by the NSF.

Stipend for NSF postdoctoral fellowships is $3400 a year. Dependency allowances will be made to married fellows. A limited allowance to aid in defraying a fellow's cost of travel will be paid, as will tuition and certain fees collected from individuals of similar academic standing. Fellows may attend any accredited nonprofit institution of higher education in this country or similar institutions abroad.

Postdoctoral fellowships will usually be awarded for an academic year of two semesters (or three quarters) or a year consisting of the regular academic year plus a full summer session. Postdoctoral fellowships may be awarded for longer or shorter periods from 6 months to 2 years upon submission by the applicant of adequate justification. Fellows who receive awards for tenures of longer or shorter duration will receive stipends and allowances in proportion to the tenure of their awards.

For applications write to the Fellowship Office, National Research Council, 2101 Constitution Ave., NW, Washington 25, D.C.

■ The award of 20 unclassified life science research contracts in the fields of medicine and biology has been announced by the U.S. Atomic Energy Commission. The contracts were awarded to universities and private institutions as part of the commission's continuing policy of assisting and fostering research and development in fields related to atomic energy as specified in the Atomic Energy Act of 1954.

Four of the awards, each of which covers a period of 1 year, are new projects; three are in the field of medicine and one is in biology. Sixteen contract renewals for 1 year were awarded to allow for continuation of research already in progress. Eight of these are in the medical sciences and eight in biology.

■ Applications for awards available 1 July 1957 will be received by the Life Insurance Medical Research Fund as follows: (i) postdoctoral research fellowships, *until 15 Oct. 1956*. Candidates may apply for support in any field of the medical sciences. Preference is given to those who wish to work on cardiovascular function and disease or related fundamental problems. The minimum stipend is $3800, with allowances for dependents and necessary travel; (ii) grants to institutions in aid of research on cardiovascular problems, *until 1 Nov. 1956*. Support is available for physiological, biochemical, and other basic work broadly related to cardiovascular problems as well as for clinical research in this field. Approximately $1 million will be available for the two types of award. Further information and application forms may be obtained from the Scientific Director, Life Insurance Medical Research Fund, 345 E. 46 St., New York 17, N.Y.

■ The Edison Foundation will make awards to the television station and the radio station judged to have best served youth. Each award will consist of a scroll and an Edison scholarship of $1000, which the station will then give to a high-school senior in the community. The student will be selected by local officials.

Nominations accompanied by a statement of 500 to 1000 words describing the achievements of the radio or television station should be sent by *1 Nov.* to the Committee on Station Awards, Thomas Alva Edison Foundation, 8 W. 40 St., New York 18, N.Y.

Erratum: In the report of the Committee on Genetic Effects of Atomic Radiation, which appeared in the 29 June issue, the number "200 million children" in line 18 of the third column on page 1163 is an error. The question should read: "What is the estimate of the total number of mutants which would be induced by this radiation dose and passed on to the next total generation of about 100 million children?"

Reports

Enzymatic Oxidation of Glucose to Glucosone in a Red Alga

The biological oxidation of gluconic acid to 2-ketogluconic acid is a well-known reaction (*1*). However, an analogous reaction, in which the second carbon of glucose is oxidized to a carbonyl group, producing an osone, has received little attention. The work of Walker *et al.* (*2*) indicated that such a reaction possibly occurs on fungi, and Berkeley (*3*) demonstrated the formation of a glucosone from glucose in the crystalline styles of Mollusca. The possible function of glucosone in the formation of glucosamine has been explored by Becker and Day (*4*) and Dorfman *et al.* (*5*).

We have shown previously that the marine red alga, *Iridophycus flaccidum*, oxidizes glucose and galactose to the corresponding aldonic acids (*6, 7*). In this report, evidence is presented that glucose and galactose are also oxidized to glucosone and galactosone, respectively, in the tissue and extracts of this alga (*8*).

In a preliminary experiment, disks cut from the thallus with a cork borer were bathed in a solution of radioactive sugar as previously described (*6*). At intervals of from 1 minute to 24 hours, the disks were removed and the tissue was inactivated by boiling in ethanol. The products present in the alcoholic extracts were then identified by means of two-dimensional paper chromatography, using solutions of phenol and water and of butanol, acetic acid, and water as solvents, followed by autoradiography of the chromatograms to locate the radioactive spots (*7*). The results showed that the major portion of the activity from the infiltrated glucose initially entered into a compound with an R_g (chromatographic movement relative to glucose) of 1.25 in the phenol-and-water solvent and 0.79 in the solvent of butanol, acetic acid, and water. This compound disappeared in the later stages of the reaction, leaving gluconic acid as the only significant product of the glucose oxidation (Fig. 1). Paper chromatographic data showed that this compound was neither a gluconolactone nor a substituted form of glucose. Similar experiments showed that the same type of reaction occurred when galactose was introduced into the plant.

For identification of this unknown compound produced from glucose, additional material was obtained by incubating radioactive glucose with sections and extracts of *Iridophycus* for short periods of time, extracting with alcohol, chromatographing the extracts, and eluting the radioactive spots from the chromatograms. The fractions representing the unknown product were pooled and this material was subjected to a number of chemical tests.

Oxidation of the unknown compound with bromine (*9*) produced a compound which migrated to the same position as an aldonic acid when it was chromatographed on paper in the afore-mentioned solvents. Reduction with sodium amalgam yielded a mixture of products, but reduction with zinc and acetic acid produced chiefly a compound having chromatographic characteristics identical with those of fructose.

For purposes of comparison radioactive glucosone was prepared synthetically (*9*) and purified chromatographically. The biologically produced material was found to cochromatograph with the major product of the chemical synthesis. When a sample of the unknown product was mixed with phenylhydrazine and sodium acetate in a capillary tube, an immediate turbidity and a color change (to bright yellow) were observed. The precipitate formed was initially amorphous, but after it had stood overnight in the cold in the sealed tube, clusters of needles that were identical in appearance with those of glucose phenylosazone (*10*) were formed. A similar reaction was observed under the same conditions with the chemically synthesized osone. This reaction did not occur with glucose alone or with glucose and an eluate from a blank paper. These tests show that glucosone is the transient compound formed as an oxidation product of glucose. The product formed from galactose was subjected to similar tests, and it was concluded that galactosone is also formed in the plant through oxidation.

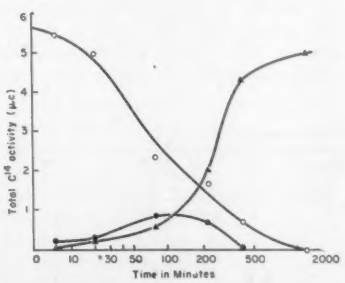

Fig. 1. Oxidation of glucose *in vivo* by *I. flaccidum*: ○, glucose; ●, glucosone; ▲, gluconic acid. For each point in the chart, 0.14 mg of C^{14}-labeled glucose (42 μc/mg) in 0.2 ml of water was incubated with two disks of 90 mg each of thallus for a given period. The disks were inactivated and extracted with hot alcohol. Aliquots of the extracts were analyzed by paper chromatography, and the radioactivity in each component was counted directly on paper.

Crude extracts of *Iridophycus* were also capable of forming glucosone and galactosone from the corresponding sugars. However, the osones did not accumulate to the same extent in the extracts as in the living tissues. Dialyzed extracts and purified sugar oxidase (*6*) from this alga did not oxidize the aldoses to osones. Thus it appears that formation of the osones is not directly related to the formation of the aldonic acids in this alga and that the two compounds may be formed by different enzymes. However, the osones can be converted to the aldonic acids through an undetermined mechanism. This is indicated by the experiments *in vivo*. Initially, comparatively high activity was observed in the osones, but, after a prolonged period of time, all the activity appeared in the aldonic acids. When isolated C^{14}-glucosone was incubated with the crude extracts of *Iridophycus*, gluconic acid was found as the only endproduct. This reaction has not yet been carried out under conditions which would permit determining whether glucose is formed as an intermediate product of the isomerization of glucosone to gluconic acid. Inasmuch as the purified oxidase from *Iridophycus* does not appear to form glucosone, it seems probable that the reaction involving the formation of osone is readily reversible to produce the original sugar, which can then be oxidized through another route directly to the aldonic acid. Further work is now in progress on the isolation and characterization of the enzyme system responsible for this oxidation reaction.

Ross C. Bean*
W. Z. Hassid

Department of Plant Biochemistry, University of California, Berkeley

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* Present address: department of plant biochemistry, Citrus Experiment Station, University of California, Riverside.

7 May 1956

"Clock" Controlled Activity Rhythms in the Fruit Fly

Recent studies in this laboratory on the daily rhythm of eclosion (*1*) in fruit flies of the genus *Drosophila* have shown that it is controlled by an interval timing device—or "clock"—that is temperature independent. It is well known that the locomotor activity of *Drosophila* adults in the field also exhibits a clear daily rhythm; activity is maximal in the evening just before sunset. A question of prime importance is whether the active period is determined by strictly exogenous factors such as light intensity, relative humidity, or temperature, or whether an internal biological timing device is involved.

Experiments in the field (*2*) have shown that temperature and humidity do not play a major role in the determination of active periods in *Drosophila*. However, it has been shown that the time and duration of active periods are correlated with definite ranges of light intensity. During the late afternoon, maximum activity occurred when the light intensity ranged between 100 ft-ca and 15 ft-ca.

To study the locomotor activity of *Drosophila* in the laboratory, a small cylindrical lucite chamber was devised with a grid of fine wires on the inside walls. Every other grid wire was connected to a common terminal. When a fly walks about in the chamber, it cannot help but short-circuit any two adjacent wires. This short circuit was detected with a high gain amplifier, and contacts per hour were translated into ink marks by an operations recorder. The virtue of this system lies in the ability of the instrument to record activity of flies under wide ranges of light intensity or even in total darkness.

Figure 1 shows the pattern of activity in *D. robusta* over a period of 7 days. Six male and six female flies were placed in the chamber with food, and the humidity of the chamber was maintained at a high level. The temperature was rigidly controlled at 21°C. For the first 4 days the flies were subjected to 12 hours of bright light (25 ft-ca incident reading) alternating with 12 hours of absolute darkness. At the onset of the fifth day, a very dim light (less than 1 ft-ca incident reading) was substituted for the bright lamp. This dim light was left on for the remainder of the experiment, and the alternating dark and bright light cycle was abolished. It can be seen that the active periods for the first 4 days were restricted to a few hours before the onset of darkness and that activity fell off abruptly when the lights suddenly went out. During the last 3 days, when the flies were in constant low light, the active periods spread to some degree, but the mean remained in phase with the previous 4 days.

These data strongly suggest that a biological "clock" is operative in determining the active periods for the flies. The absolute amount of activity declined during the last 3 days of the experiment; this was probably the result of the depressing effect of dim illumination. Previous experiments in which flies were subjected to several days in absolute darkness bear this out. The amount of activity in total darkness was so slight that no rhythm could be detected.

Besides the fact that a rhythm of activity persists under constant conditions of illumination, it is also interesting to note the pattern of activity during the first 4 days of alternating light and dark. The onset of the evening peaks occurred quite regularly at about 7 P.M. without reference to any gradual fluctuation in light intensity, temperature, or relative humidity as would exist in the field. It appears then, that under alternating light conditions where the lights are turned on and off abruptly, the commencement of activity is under "clock" control.

SHEPHERD K. DE F. ROBERTS
Graduate College, Department of Biology, Princeton University, Princeton, New Jersey

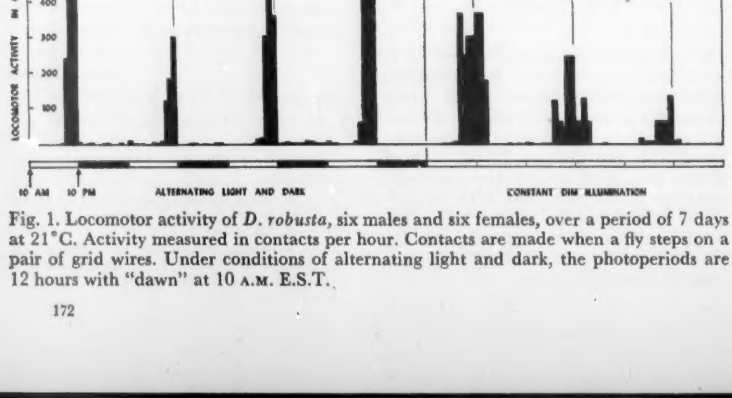

Fig. 1. Locomotor activity of *D. robusta*, six males and six females, over a period of 7 days at 21°C. Activity measured in contacts per hour. Contacts are made when a fly steps on a pair of grid wires. Under conditions of alternating light and dark, the photoperiods are 12 hours with "dawn" at 10 A.M. E.S.T.

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11 April 1956

Hardness of Substances in the Ideal State

The relation proposed by Tabor (*1*) between Vickers indentation hardness, H_v, and ultimate tensile strength, T_u, of an ideal plastic material, $T_u = 0.33\ H_v$, may be used to calculate a hardness of the material in the ideal state since methods are known for calculating the "ideal ultimate tensile strength." The results of such calculations are interesting even though they may be considered only as approximations.

Griffith (*2*) has measured fracture strengths as large as 9×10^5 lb/in.^{2} for fine glass fibers as compared with a theoretical strength of 1.6×10^6 lb/in.^{2} and a measured strength of 2.49×10^4 lb/in.^{2} for rods of the same glass. The fine fibers have a strength of 633 kg/mm^2 and therefore a calculated Vickers hardness of 1900. This is equivalent to the hardness of corundum or a Moh's hardness of 9 as compared with about 4.5 for ordinary glass.

Herring and Galt (*3*) have measured the elastic properties of single perfect "whiskers" of tin and found a yield stress of 200,000 lb/in.^{2} The application of Tabor's equation yields a Vickers hardness of 141 for the whisker as compared with about 21 for hard drawn tin.

Zwicky (*4*) has calculated a strength of 200 kg/mm^2 for sodium chloride. The calculated Vickers hardness is 600, equivalent to a Moh's hardness of 5. The

Moh's hardness of massive sodium chloride is 2.

Unfortunately, no data are available on the tensile strength of diamond, but, judging from the examples I have given, the ideal hardness should be at least several times the observed value. Tabor shows measured values for the indentation hardness to be 8000 to 10,000 kg/mm² for diamond. This yields a tensile strength of 4 to 5 × 10^6 lb/in.², a truly remarkable value.

It seems obvious that greatly improved abrasives might be made from relatively inexpensive substances such as aluminum oxide and silicon carbide. These materials in ideal form might be harder than diamond. The attempt to make substances in ideal form for abrasives has several attractive features as compared with an attempt to make massive pieces ideally hard, or with attempts to make superstrong metals: (i) large pieces are not required—small grains can be used as an abrasive powder; and (ii) the consequences of transformation to the non-ideal form are less severe.

ARTHUR E. NEWKIRK
Chemistry Research Department, General Electric Research Laboratory, Schenectady, New York

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27 April 1956

Lactic Dehydrogenase Activity of Serum in Mice with Transplantable Leukemia

The finding that the serum activity of lactic dehydrogenase (LD) is elevated during acute and chronic human leukemia (*1*) prompted the study reported here of the alterations of serum lactic dehydrogenase (SLD) during the course of mouse leukemia (*2*). The purposes of this study were (i) to ascertain the relationship, if any, between SLD and the course of experimental mouse leukemia and (ii) to determine whether there was any correlation between SLD and the various types of experimental transplantable mouse leukemia.

Four lines of leukemia in mice were examined to determine whether alterations in the activity of SLD occurs during the course of the disease. Lines I, 8174, and 82B are acute stem-cell leukemias probably lymphocytic in character. Line C1498 arose spontaneously as a myeloid leukemia. Line-I leukemia, carried in C58 mice, was supplied to the Sloan-Kettering Institute by E. C. MacDowell and has since been kept in passage in F1 (C58 by BALB) mice by the intraperitoneal inoculation of 10 to 20 million cells from minced spleen of leukemic donors. The survival time of the inoculated animals is 4 to 7 days.

Table 1. Serum lactic dehydrogenase activity in mice inoculated intraperitoneally with a suspension of specified leukemic cells.

Days of inoculation	SLD* (units/ml)			
	82B	C1498	I	8174
1	1000	1200	3200	2500
2	1900	1600	6200	2900
3	3000	3300	24,000	5300
4	5400	5500	no survivors	7100
7	3700	3200		6300
8	2900	4700		10,000
9	3700	7200		15,000
10	3900	5200		18,000
11	3200	6200		40,000
15	11,000	14,000		25,000†
16	20,000	44,000†		no survivors
17	no survivors	no survivors		no survivors
Control mice	1100 ± 300 (F1)‡	1200 ± 260 (C57 BL/6)§	1100 ± 300 (F1)‡	1100 ± 300 (F1)‡

* Average of two individual determinations. † One mouse only. ‡ Average of determinations on 23 mice. § Average of determinations on 21 mice.

Leukemia 8174 arose spontaneously in an F1 (C58 by BALB) ex-breeder in the laboratory of Joseph Burchenal. It was converted to ascitic form and is passed in the same strain of mice by the intraperitoneal inoculation of ascitic fluid containing approximately 20 million cells. Survival time is 12 to 16 days. Leukemia 82B also originated in an F1 (C58 by BALB) ex-breeder in Burchenal's laboratory. It is transferred into the same strain of mice by the intraperitoneal inoculation of approximately 10 million cells from minced tumor of leukemic donors. Survival time is 12 to 16 days.

Leukemia C1498 arose as a spontaneous myelocytic leukemia in C57 BL/6 mice. At the present time, however, it is not considered histologically typical of that type of leukemia. This strain was received from Jackson Laboratory, Bar Harbor, Maine. It is transferred in mice of C57 BL/6 strain by inoculation of approximately 10 million cells from minced tumor of leukemic donors. Survival time is 10 to 16 days.

A designated number of mice were inoculated with each type of leukemia. An equal number of untreated control mice of C57 BL/6 and F1 mice were set aside. At daily intervals, two mice from each leukemic group and two from each control group were bled from the branchial artery with syringes that had been moistened with saline before use. The serum was separated from each sample, and individual analysis of SLD was made. The average of each two determinations was recorded.

Serum lactic dehydrogenase activity was measured by the method previously described (*1*). The reaction was followed in a Beckman model DU spectrophotometer using a tungsten light source. The activity is expressed as units per milliliter of serum, per minute. One unit equals a decrease in optical density of 0.001 per minute, per milliliter under the conditions described. The mean value of SLD, based on individual determinations on the serum of 23 normal F1 (C58 by BALB) mice, was 1100 ± 320. The mean value, based on the determination of the serum of 21 normal C57 BL/6 mice, was 1200 ± 260.

In mice inoculated with line-I leukemia, which is associated with the shortest survival time of those in this study, an increase in SLD was apparent within 24 hours after injection. Terminally, SLD rose to 24,000 units. Those mice inoculated with the cells of leukemia 8174 showed a slower but progressive rise in SLD activity, reaching a maximum terminally. Inoculation with C1498 and with 82B leukemia resulted in similar increments of SLD activity (Table 1).

The mechanism of the elevation of SLD during experimental mouse leukemia and human leukemia has yet to

Table 2. Comparison of lactic dehydrogenase activity of selected tissue homogenates from control and leukemic mice.

Tissue	Lactic dehydrogenase activity (units/gram wet tissue)	
	Untreated control*	Leukemic†
Serum	760	60,000
Lymph node	80,000	280,000
Liver	130,000	280,000
Spleen	100,000	230,000

* F1 mouse. † F1 mouse inoculated 16 days previously with leukemia 82B.

be explained. Lactic dehydrogenase activity was measured in homogenates of various tissues from an untreated control F1 mouse and an F1 mouse that had been inoculated with leukemia 82B 16 days previously. The SLD of the control mouse was 760 units and that of the leukemic mouse 60,000 units. Table 2 compares the LD activity per gram of wet tissue in these two mice. The serum levels present the most striking differences between the leukemic and nonleukemic mouse. A comparison of the LD activity of the other tissues reveals higher values in the homogenates of the viscera of the leukemic mouse, although the differences are not as impressive as those observed in the serum.

The observations on various mouse leukemias reported here indicate that mouse leukemias, like some human leukemias, result in an increase in SLD. The mechanism of the increased serum activity is unknown.

CHARLOTTE FRIEND
FELIX WRÓBLEWSKI
Sloan Kettering Institute and
Department of Medicine,
Memorial Center, New York

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30 March 1956

Evolution of Respiratory Enzyme System during Germination of Bacillus subtilis

Church and Halvorson (*1*) reported that intact spores of *Bacillus cereus,* following activation by heat, oxidize glucose, gluconate, 2-ketogluconate, and pyruvate, but fail to oxidize glucose-6-phosphate, fructose-6-phosphate, hexose diphosphate, acetate, ribose, or fructose. On the other hand, cell-free extracts of spores of the same species which have been prepared by sonic oscillation or by grinding oxidize glucose and pyruvate but not gluconate, 2-ketogluconate, glucose-6-phosphate, fructose-6-phosphate, or hexose diphosphate. Hardwick and Foster (*2*), after working with cell-free extracts of spores from several aerobic bacteria, reported an absence of any measurable respiratory enzymes.

In a previous report (*3*), we showed that spores of *Bacillus subtilis* (PCI 219) develop into vegetative forms after passing through four separate phases—namely, resting spores, appearance of translucent area in spores, formation of germ pores, and emergence of a new bacillus. In this report, it is observed that respiratory-enzyme systems are formed according to the phase of development of spore germination and that respiratory-enzyme systems of germinating spores differ from those present in vegetative forms.

Spores of *B. subtilis* (PCI 219) were harvested from a 5-day culture grown on a meat-extract agar medium at 37°C, heated at 80°C for 20 minutes, and then washed in distilled water three times and resuspended in distilled water. The spores of this suspension were used as resting spores for the experiment. Oxygen uptake by spores was measured in a Warburg manometer at 37°C.

In the presence of L-asparagine, the resting spores showed an increased uptake of oxygen when caramelized glucose was used as the substrate instead of the unheated glucose. It was previously reported (*4*) that a significant number of spores of *B. subtilis* (PCI 219) will change to the translucent spore stage from the resting stage if the phosphate-buffer solution contains a caramelized sugar (glucose, fructose, maltose, lactose, or sucrose) instead of unheated sugar with one of the amino acids (L-asparagine, DL-isoleucine, DL-serine, or DL-valine).

It is apparent that the factors which favor translucent-spore formation as previously reported (*4*) also result in an increased oxygen uptake by the resting spores. In other words, resting spores change to the translucent spores in a phosphate buffer that contains caramelized glucose and L-asparagine; they also show an oxygen uptake. On the other hand, almost none of the resting spores in a phosphate buffer that contains unheated glucose and L-asparagine change to the translucent forms or show a measurable oxygen uptake. An examination to determine whether translucent spores are able to oxidize unheated glucose was therefore conducted.

Translucent spores were prepared by incubating the resting spores in the phosphate solution containing caramelized glucose (1 percent) and L-asparagine (1.5 mg/ml) for 1 hour at 37°C. These translucent spores were washed in distilled water three times and resuspended in distilled water. Manometric data are given in Fig. 1, where results clearly indicate that the translucent spores rapidly oxidize unheated glucose.

To determine the pathways of oxidation of glucose by the translucent spores, two experiments were performed. In one, some intermediates of glycolysis and of the tricarboxylic acid cycle were used as substrates, and, in the other, some inhibitors were used. Manometric data from these experiments are give in Table 1. These data indicate that the translucent spores do not oxidize fructose-1, 6-diphosphate, pyruvate, citrate, succinate, or malate and that the oxidation of glucose is not inhibited by HCN or NaF. These facts show that glucose oxidation by the translucent spores may not proceed on the pathways of Embden-Meyerhof and the tricarboxylic acid cycle.

Table 1. Oxygen uptake by the translucent spores in the presence of various intermediates of the tricarboxylic acid cycle and the Embden-Meyerhof pathway. The Warburg vessels contained 0.5 ml of translucent spore suspension, 0.2 ml of substrate, 0.1 ml of inhibitor, and 1.5 ml of 0.1*M* phosphate buffer at *p*H 7.2 and 37°C in a fluid volume of 3 ml.

Substrate	Inhibitor	QO_2 (*N*)
0.1*M* Glucose		138.84
0.1*M* Malate		42.65
0.1*M* Pyruvate		44.47
0.1*M* Succinate		42.22
0.1*M* Citrate		38.12
0.1*M* Fructose-1, 6-diphosphate		61.41
Endogenous		39.53
0.1*M* Glucose	0.01*M* HCN	139.14
0.1*M* Glucose	0.01*M* NaF	151.80

Vegetative forms of *B. subtilis* are able to oxidize glucose-6-phosphate, fructose-1,6-diphosphate, pyruvate, malate, or succinate. Moreover, these oxidations are inhibited by HCN and NaF. It seems, therefore, that glucose oxidation in translucent spores differs from that in vegetative forms.

To determine the pathways of glucose oxidation by the translucent spore, we used sodium gluconate as a substrate first. The results are shown in Fig. 1. It is clear

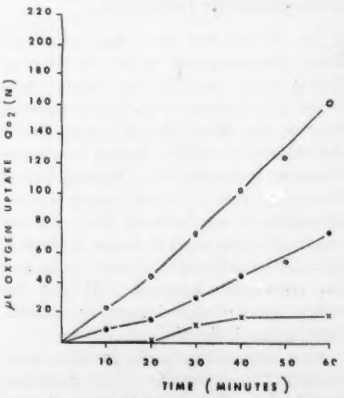

Fig. 1. Unheated glucose and sodium gluconate oxidation by translucent spores: ○—○, glucose; ●—●, gluconate; ×—×, endogenous. The Warburg vessels contained 0.5 ml of translucent spore suspension, 0.2 ml of substrate, and 1.5 ml of 0.1*M* phosphate buffer at *p*H 7.2 and 37°C in a fluid volume of 3 ml.

from these data that gluconate is oxidized by the translucent spores. There are two known ways by which glucose is oxidized to gluconic acid. One is the Warburg-Dickens-Lipmann-Horecker pathway (*5*) and the other is the Stokes-Campbell route (*5*). The former requires the presence of phosphoric acid, but the latter does not. We found that glucose and gluconate oxidation proceeded in veronal buffer, which is phosphate-free, as efficiently as in phophate buffer. This would eliminate the Warburg-Dickens-Lipmann-Horecker pathway.

It is interesting to note that vegetative forms of this species have the cytochrome system and other oxidative enzymes (*6*), whereas the germinating spores can oxidize glucose or gluconate only in a phosphate-free buffer.

From this fact it may be assumed that the glucose oxidative enzyme system of *B. subtilis* (PCI 219) may develop in a stepwise manner as germination proceeds and as the cells change into the vegetative form.

Y. Hachisuka*, N. Asano,
M. Kaneko, T. Kanbe
Department of Bacteriology,
Nagoya University School of Medicine,
Nagoya, Japan

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* Present address: University of Texas M. D. Anderson Hospital and Tumor Institute, Texas Medical Center, Houston.

27 April 1956

Rapid Ion-Exchange Method for Determining Total Fluoride in Impure KF · HF

As a result of the continuing need for large numbers of control analyses on electrolyte for fluorine generation cells at this plant, it became necessary to develop a rapid method of analyzing potassium acid fluoride (KF · HF) for total fluoride content (*1*). Accuracy comparable to that of the photofluorimetric method (2), which has been in use, was required. Consequently, an ion-exchange technique was investigated, and a procedure was developed, modifying the general methods described by Honda (*3*) and Roper et al. (*4*), in which the cations are removed from the solution, and the fluoride-containing eluant is titrated with NaOH.

A sulfonated hydrocarbon cation exchange resin (Rohm and Haas Amberlite IR-120) supported on 100-mesh nickel screen is used in the simple apparatus shown in Fig. 1. The resin is first activated by washing with 1 lit of 2-percent H_2SO_4 at 30ml/min., the acid that remains in the tube being washed out with distilled water. The weighed electrolyte sample (impure KF · HF) is dissolved in distilled water, and an aliquot of about 10 ml is passed through the ion-exchange column into a 400-ml polyethylene beaker. The column is then washed with distilled water until there is about 275 ml of eluate. This solution is then titrated to a phenolphthalein endpoint with NaOH solution prepared from CO_2-free NaOH and standardized at approximately *0.1N* with NaF.

Samples of known amounts of reagent-grade NaF which were dried at 110°C for 24 hours were used to check the method prior to applying it to samples of KF · HF electrolyte. Good results, which are shown in Table 1, were obtained by using the procedure outlined here. As a further check, this ion-exchange procedure was directly compared against the photofluorimetric technique previously used by analyzing parts of the same electrolyte sample (impure KF · HF) by both methods. The portion for photofluorimetric analysis was steam-distilled and titrated with thorium nitrate in a modified Klett fluorimeter, using morin as the indicator; the portion for ion-exchange analysis was handled as described in preceding paragraphs. Results, in terms of percentage of fluoride found, are shown in Table 2.

The values obtained, together with data subsequently obtained in routine use of this procedure, show that it yields results of accuracy comparable to that obtained by the photofluorimetric method in about one-fourth of the previously required time. In general, the titration is correct to 1 or 2 drops with phenolphthalein as the indicator. Simple checks showed that accuracy was not affected by varying the rate of flow of sample and wash water in the column between 5 and 30 ml per minute or by varying the depth of resin in the column from 6 in. to 12 in. It was found, however, that the higher rates of flow with a 6-in. resin bed gave slightly erratic results. A single 12-in. bed has been used intermittently for 3 weeks (approximately 50 determinations) without regeneration. Since regeneration is easily accomplished with 2-percent H_2SO_4, the resin may be used indefinitely.

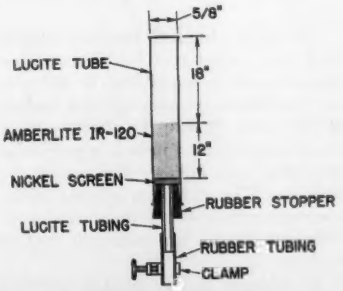

Fig. 1. Ion-exchange column.

Table 1. Results of analyses of samples of known fluoride content.

Sample	Fluoride present (mg)	Fluoride found (mg)
1	63.34	63.67
2	55.87	55.87
3	57.23	57.43
4	58.54	58.53
5	55.69	55.61
6	50.80	50.80
7	47.55	47.54
8	47.14	47.08
Avg.	54.52	54.57

Table 2. Comparison of percentage of fluoride found by ion-exchange and photofluorimetric methods in impure KF · HF samples.

Sample	Photofluorimetric method	Ion-exchange method
1	58.81	58.73
2	58.85	58.72
3	58.80	58.77
4	58.86	58.80
Avg.	58.83	58.76

F. A. Koehler
W. A. Levier
Special Analysis Department, Technical Division, Goodyear Atomic Corporation, Portsmouth, Ohio

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9 April 1956

Ratio of Ionium to Uranium in Coral Limestone

Samples of coral limestone cuttings taken over the first 200 feet in drilling on Elugelab Island during the summer of 1952 (*1*) have been analyzed for uranium by the sodium fluoride fluorometric method and for ionium by a radiochemical procedure which involves carrier-free separation of the total thorium in the

Table 1. Experimental results. The sample numbers indicate the depth range in feet over which the sample was collected. The numbers in column 4 were calculated from the ionium and uranium contents of the samples, taking the values 8.0×10^4 years and 4.49×10^9 years as the half-lives of ionium and uranium, respectively. The uncertainties indicated are the expected standard deviations, based on the number of counts taken and on the estimate that the standard deviation in the uranium determination is ± 5 percent.

Sample No.	Uranium (ppm)	Ionium (10^{-5} ppm)	$\frac{N_{Io}\lambda_{Io}}{N_{U_I}\lambda_{U_I}}$
Y*† (surface)	0.83	< 0.1	< 0.07
		< 0.1	< 0.07
F_1 20–45	3.24, 3.14, 2.95	< 0.2	< 0.04
	2.93, 3.00		
F_1 45–55	3.73, 3.74	« 0.2	« 0.03
	3.64, 3.56		
F_1 55–60	4.68, 4.91	« 0.1	« 0.01
		« 0.1	« 0.01
F_1 60–70	5.22, 4.91	1.36 (± 0.05)	0.16 (± 0.01)
		1.48 (± 0.09)	0.17 (± 0.01)
F_1 70–80†	5.52, 5.18, 5.35	2.5 (± 0.2)	0.27 (± 0.03)
F_1 80–90	4.41, 4.59	3.8 (± 0.1)	0.49 (± 0.03)
F_1 90–100	4.07, 4.20	3.5 (± 0.2)	0.49 (± 0.04)
F_1 100–110	3.53, 3.64	4.3 (± 0.2)	0.70 (± 0.05)
		4.3 (± 0.2)	0.70 (± 0.05)
F_1 110–120†	4.08	2.6 (± 0.1)	0.37 (± 0.03)
		2.7 (± 0.1)	0.38 (± 0.03)
		2.8 (± 0.1)	0.40 (± 0.03)
F_1 120–130†	4.10	3.1 (± 0.2)	0.44 (± 0.04)
F_1 130–140†	4.04, 4.04	2.9 (± 0.1)	0.42 (± 0.03)
F_1 140–150	3.72	2.7 (± 0.1)	0.42 (± 0.03)
		2.6 (± 0.1)	0.41 (± 0.03)
F_1 150–160†	3.12	3.4 (± 0.2)	0.63 (± 0.05)
		3.5 (± 0.2)	0.65 (± 0.05)
F_1 160–170†	4.00	4.38 (± 0.05)	0.64 (± 0.03)
		4.29 (± 0.05)	0.62 (± 0.03)
F_1 170–180	3.08	3.7 (± 0.1)	0.70 (± 0.04)
F_1 180–190	2.90	4.3 (± 0.2)	0.86 (± 0.06)
		4.0 (± 0.2)	0.80 (± 0.06)
		4.4 (± 0.1)	0.88 (± 0.06)
		4.4 (± 0.1)	0.88 (± 0.06)

* Sample Y was a 360-g cluster of coral collected near the surface on Yurochi Island (Bikini). The entire piece was dissolved. Aliquots of the solution were analyzed.
† Samples in which ionium and uranium were determined by analysis of aliquots of the same solution. In other samples, separate portions of ground and well-mixed solid sample were used for ionium and uranium analysis.

sample by thenoyltrifluoroacetone extraction and ion-exchange techniques, followed by pulse analysis of the alpha activity in the separated thorium (*2, 3*).

The ionium content of the coral was found to vary with the depth in a fairly simple manner. Near the surface, the coral contains less than 2×10^{-6} ppm of ionium. With increasing depth, the ionium content first increases, reaches a value of 4×10^{-5} ppm at 100 feet, decreases sharply to about 2×10^{-5} ppm, then increases again, reaching a value of 4×10^{-5} ppm at 160 feet (Table 1).

The uranium content of the Elugelab coral also varies somewhat, but within much narrower limits—2.9 to 5.5 ppm.

On examination of the data obtained in the analysis of 16 samples over the depth range of 20 to 190 feet, it becomes apparent that coral near the surface contains far less than the equilibrium quantity of ionium. In a sample collected at 60 to 70 feet, for example, one calculates —on the basis of the uranium content— 8.7×10^{-5} ppm of ionium for secular equilibrium. The ionium found, 1.4×10^{-5} ppm, is only 16 percent of the equilibrium quantity. In a sample still nearer the surface, 20 to 45 feet, there is less than 4 percent of the amount of ionium required for equilibrium. At a depth of 100 to 110 feet, however, the coral contains approximately 70 percent of the equilibrium quantity of ionium calculated on the basis of the known uranium content.

The data obtained thus far suggest that, in the absence of leaching or other processes which would lead to differential movement of uranium and ionium in the coral deposit, the magnitude of the ionium-uranium ratio in a particular specimen may indicate the age of the specimen. This statement is based on the assumption that newly formed corals contain uranium but are essentially free of ionium.

In addition to the samples reported here, ten cutting samples from the Parry Island drilling (*1*) have been analyzed. It is interesting to note that among the coral samples analyzed to date none has been found which contains ionium in excess of the amount required for secular equilibrium with the uranium present. If separation of uranium from ionium occurs in the coral, one may expect to encounter such samples.

Core samples taken over the entire depth range in the Eniwetok drillings, live corals, and other calcareous marine deposits are now being analyzed.

J. W. Barnes
E. J. Lang
H. A. Potratz*
Los Alamos Scientific Laboratory, Los Alamos, New Mexico

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* Academic address: Department of Chemistry, Washington University, St. Louis, Mo.

19 March 1956

Flotational Lipoproteins Extracted from Human Atherosclerotic Aortas

In view of the interest in the relation between the lipoproteins in serum and atherosclerotic activity (*1, 2*), an examination of human aortas for the presence of similar lipoprotein fractions seemed mandatory. Experiments with rabbits that were force-fed cholesterol have shown a remarkable correlation between atherosclerotic lesions and the S_f 10-30 class of lipoproteins in the serum (*1*). In human serum any relationships are complicated by diverse, normal classes of lipoproteins, so that interpretation becomes highly statistical (*3*). Also, plaques cannot be evaluated because of the obvious inaccessibility of the tissues.

Accordingly, we have endeavored to extract fractions from aortas of fresh human necropsies similar to those observed in serum and to assess them quantitatively by ultracentrifugal flotation (*4*). These findings are compared with the degree of atherosclerosis of each extracted aorta and with the cause of death where it was classified as cardiovascular or noncardiovascular.

Aortas from both sexes were obtained from a 500-bed general hospital. Autopsies were performed 1 to 8 hours after death. Three inches of thoracic aorta just above the diaphragm were taken. They were placed in 0.9-percent NaCl and maintained at 4°C for less than 1 week.

The cause of death was determined

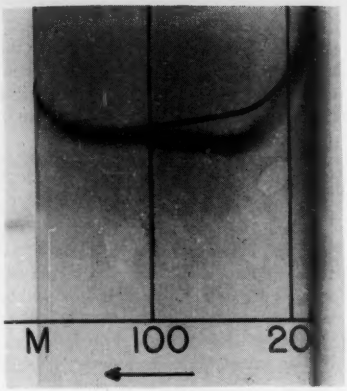

Fig. 1. Flotational optical pattern of pooled extracts from aortas showing predominance of S_f 20–100; S_f 20, S_f 100, and baseline for the cell were drawn in 2 minutes after a speed of 52,640 rev/min was attained. The area delineated by these boundaries is proportional to the concentration. Arrow indicates direction of flotation; *M* is the meniscus.

by the pathologist. The cardiovascular deaths included myocardial infarctions, cardiac failures, and one aortic aneurysm. The other deaths were noncardiovascular.

The intima was peeled from the media. The calcium deposit, if present, was delivered from the plaque and discarded to prevent dilution of the tissue. Held before a lamp, the opaque plaque was dissected from the unaffected transparent intima, which was discarded. When the specimen contained only linear streaks of fatty deposits or was devoid of lesions, that area of the intima was diced.

Classification of the intimas by degree of atherosclerosis was based on their opacity before the lamp. Degree I represents no apparent atherosclerosis or streaking, and degree II represents the presence of plaques in varying amounts. One-half-gram to 4.0-g samples were blotted and weighed. They were extracted with NaCl $\rho = 1.065$ (20/20) after maceration in a glass tissue grinder. Two 7.0-ml extractions at 4°C for 24 hours each removed all the extractable substances. They were clarified by low-speed centrifugation, were adjusted to 9-ml volume and $\rho = 1.065$ (20/20) with NaCl, and were treated thereafter exactly as in the flotational preparation and analysis of the lipoproteins of low density from serum (*5, 6*). The results were combined, and the concentrations were calculated as milligrams per 100 g of wet tissue. A flotational pattern of a pool of 20 degree-II preparations is shown in Fig. 1. A sample of the S_f 12–100 fraction from pooled serums was prepared in a separation cell (*6*) for comparison with the degree-II pool.

Table 1 describes the skewed distributions of several groupings of the 41 aortas. They are expressed as their 67th percentiles with the distribution's total range. The P_{67} is defined as that value below which 67 percent of the values in a distribution fall. The 41 aortas may be divided into one group graded as degree I (no plaques) and another graded as degree II (plaques). The degree-I preparations were found to contain no flotational materials at P_{67} and negligible amounts above this point. In contrast, the degree-II preparations contained substantial amounts at P_{67} and above for the S_f 12–100 fractions. The 41 aortas also may be divided into two groups illustrating a strong association of S_f 12–100 and plaques with cardiovascular death and a weak association with noncardiovascular death.

Our observations indicate an almost perfect correlation among plaques, cardiovascular death, and the presence of the S_f 12–100 fractions in aortas. Then the question of the identity, or at least the similarity, of the S_f 12–100 fractions from aortas and serums becomes pertinent. Because of the continuous flotational heterogeneity from S_f 12 to 100 of the fractions from both sources, and because of the small amounts of the aorta preparations available, exact identification is impossible. Nevertheless, several similarities are readily apparent. Both fractions are soluble in, and are prepared in, the same solvent under identical conditions (*5*). Both migrate with the same characteristics in a centrifugal field at comparable concentrations. At a concentration of 0.03 percent, both fractions give a negative biuret test for protein and a positive test for lipid in the presence of osmium tetraoxide (OsO_4) vapor. If it is assumed that the two fractions are closely similar heterogeneous mixtures, several conclusions may be drawn.

The most prominent lipoprotein fraction occurring in serum S_f 0–12, is absent almost completely in the aorta extracts, regardless of the presence or absence of plaques. This fact implies that this fraction is unassociated with atherosclerotic activity and is merely a normal component of serum.

The S_f 12–100 is always present in substantial amounts in aortas where there is atherosclerotic activity. It is usually present in serums in widely varying concentrations. Therefore, its presence in serums may be a reflection of this activity along with other factors.

When S_f 12–100 from aortas is analyzed as S_f 12–20 and 20–100, the latter subfraction contains most of the lipoprotein.

The absence of S_f 0–12 in all of the aortas implies that this fraction neither is forced from the serum into the intima (*7*), nor does it arise in the intima ordinarily to be released into the serum.

The association of cardiovascular death with the S_f 12–100 fraction from aortas and with the presence of plaques is very strong. It appears in ten of the 11 such deaths, no plaques having been observed in the eleventh case.

Among the noncardiovascular deaths, association between plaques and substantial concentrations of the S_f 12–100 fraction is perfect in 19 instances attributing much significance to this fraction. Its absence in the remaining 11 noncardiovascular deaths, where no plaques were observed, supports this contention.

MARTIN HANIG
JOHN R. SHAINOFF
ALEXANDER D. LOWY, JR.*
Department of Biophysics, University of Pittsburgh, Pittsburgh, Pennsylvania

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Table 1. Degree of atherosclerosis and concentrations of lipoprotein fractions extracted from human aortas (67th percentiles* in milligrams per 100 gm wet tissue).

Degree	*N*	Avg. age†	S_f 0–12	Total range	S_f 12–20	Total range	S_f 20–100	Total range
				All aortas				
I	12	49.0‡	0	0–5	0	0–14	0	0–30
II	29	66.8	0	0–40	26	0–140	110	32–570
				Aortas from cardiovascular deaths				
I	1	58.0	0	0–0	0	0–0	0	0–0
II	10	60.2§	0	0–40	20	0–40	105	35–135
				Aortas from noncardiovascular deaths				
I	11	48.1‡	0	0–5	0	0–14	0	0–30
II	19	69.9	0	0–0	27	0–140	125	32–570

* P_{67} is that value below which 67 percent of the values in a distribution fall. † Age range, 28–90. ‡ Three-day-old baby not averaged. § Age unknown for one.

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* Present address: School of Medicine, University of Pittsburgh.

30 March 1956

Consistent Set of Running Times

In earlier papers (*1*, *2*) it has been shown that a logarithmic relationship exists between various types of racing events. It was pointed out that a consequence of the linear log-log relationship between distance and time was a linear correspondence between the log of the average rate for a given distance and the log of the distance. This phenomenon applies not only to running events but to all types of racing—for example, walking, swimming, bicycle racing, and horse racing. The slope of the latter plot was defined as an "exhaustion constant" since it is a measure of how the average rates decrease with distance. The present communication shows how the log rate-log distance plot can be used to derive a consistent set of running times based on the best efforts to date.

When $\bar{r}$ (the average rate for a given distance) is plotted against the distance d, as has been done previously (*1*, *2*), it is very difficult to decide which records are actually "best efforts," for the exact shape of the curve through the points has not been determined. However, this difficulty is removed when log $\bar{r}$ is plotted against log d. Since this plot must be linear (*2*) it is easy to determine which records are not consistent with the "best efforts," for all "best efforts" must fall in a straight line, and all other records below. To determine the times in which all records below the line should be performed to put them on the line it is necesary merely to divide the distance by the rate on the line.

In order to prepare a table of consistent times for running events, a plot of log $\bar{r}$ versus log d was made for all the world records. The plot was divided into two parts for convenience, one plot for the records for distances up to 1 mile and another for the records from 1 mile to the 2-hour run.

Table 1 presents a set of times for running events that has been derived from the linear log $\bar{r}$ versus log d plots. The 100-yard and 100-meter events have not been considered because of the strong effect of the start on these events which causes a considerable deviation from the straight-line function. It is obvious that the 220-yard, 1-mile, and 1-hour records are all equivalent performances and "best efforts," and that all other records need improvement to make them consistent. The amount of improvement necessary (Δt) is indicated in column 4 of Table 1. The last column of Table 1 shows the amounts (Δt) by which the present Olympic records can be bettered to bring them into line with the best efforts to date.

Table 1. Consistent times for running events.

Distance	Time (hr: min: sec)	Consistent time (hr: min: sec)	Δt (sec)	Δt for present Olympic records (sec)
220 yd	0:0:20.1	0:0:20.1	0	
440 yd	0:0:46.0	0:0:45.8	0.2	
880 yd	0:1:48.6	0:1:44.5	4.1	
1 mi	0:3:58.0	0:3:58.0	0	
2 mi	0:8:40.4	0:8:22.1	18.3	
3 mi	0:13:14.2	0:12:57.6	16.6	
6 mi	0:27:59.2	0:27:19.8	39.4	
10 mi	0:48:12.0	0:47:23.3	48.7	
15 mi	1:16:26.4	1:13:22.4	184.0	
200 m	0:0:20.2	0:0:20.0	0.2	0.7
400 m	0:0:45.8	0:0:45.5	0.3	0.4
800 m	0:1:46.6	0:1:43.7	2.9	5.5
1,000 m	0:2:19.5	0:2:15.3	4.2	
1,500 m	0:3:41.8	0:3:39.1	2.7	6.1
2,000 m	0:5:07.0	0:5:01.0	6.0	
3,000 m	0:7:58.8	0:7:45.8	13.0	
5,000 m	0:13:40.6	0:13:27.3	13.3	38.7
10,000 m	0:28:54.2	0:28:24.3	29.9	52.7
15,000 m	0:44:54.6	0:43:43.2	71.4	
20,000 m	0:59:51.7	0:59:51.5	0.2	
25,000 m	1:16:34.6	1:16:11.9	22.7	
30,000 m	1:35:23.8	1:32:40.7	163.1	
12 mi, 809 yd	1 hr	1 hr	12 mi, 809 yd*	
22 mi, 418 yd	2 hr	2 hr	23 mi, 1373 yd*	

* Consistent distance.

It should be strongly emphasized that the rates which fall on the straight-line plots are in no sense "ultimates." The rates will be increased by better training methods, better nutrition, and improved tracks and equipment. However, the underlying logarithmic relationships will be maintained so that at any time it will be possible to show which records are out of line when compared with the best efforts.

M. H. Lietzke
Oak Ridge National Laboratory, Oak Ridge, Tennessee

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20 April 1956

Comparison of Pinch-Caliper and X-ray Measurements of Skin plus Subcutaneous Fat

Although numerous studies of subcutaneous fat have appeared, only one previous report has dealt with the relationship between its roentgenogrammetric measurement and its measurement by spring-loaded pinch calipers in males (*1*).

In the present study (*2*) the thickness of the fat-plus-skin layer, at the level of the lowest rib at the midaxillary line, was measured by both techniques. Pinch-calipers exerting a force of 300 g over a 30 mm² area (*3*) were used to measure a double "fatfold," while measurements of the single-thickness shadow were made on standardized teleoroentgenograms (*4*).

Agreement between the two methods was high ($r = 0.88$) for 65 young men aged 21 to 22 years, thus confirming Baker's findings for thigh and arm fat (*1*). The median pinch-caliper value was 12.0 mm, while the median roentgenogrammetric measurement was 9.3 mm. On this basis, the actual pinch-caliper values were 65 percent of the true double-fold thickness (18.6 mm).

The possibility that the skinfolds were reduced 35 percent throughout the entire range was tested by comparing the distribution of pinch-caliper values to the roentgenogrammetrically determined values multiplied by 1.3. Using the Kolmogorov-Smirnov test (*5*), the two distributions were not significantly different at the 5-percent level (Fig. 1).

The two methods of measuring skin

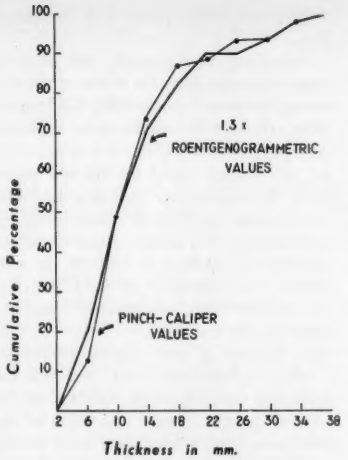

Fig. 1. Comparative cumulative frequency distributions of pinch-caliper thicknesses (dotted line) and roentgenogrammetrically determined thicknesses (heavy line). Since the roentgenogrammetric values multiplied by 1.3 are in close agreement with the pinch-caliper values, it is likely that reduction of the true values by compression is a constant 35 percent.

plus subcutaneous fat thus agree well at this particular site. Percentage compression appears to be constant over the full range of pinch-caliper values obtained (*6*).

Note added in proof: Correlations ranging between 0.8 and 0.9 were obtained by W. H. Hammond (*7*) for boys and girls of unspecified age.

STANLEY M. GARN
Fels Research Institute, Antioch College, Yellow Springs, Ohio

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30 March 1956

Chamber for Microelectrode Studies in the Cerebral Cortex

One of the problems encountered in recording action potentials from single cells in the cerebral cortex is the prevention of undesired movements of the exposed cortex. These movements, chiefly of cardiac and respiratory origin, are large enough to cause significant displacements of a cortical nerve cell relative to a fixed microelectrode tip, and they make it difficult to record the activity of the cell for extended periods of time. Thus, some method is needed for immobilizing the exposed cortex when a microelectrode is in the cortical tissue. It has been known for a long time (*1*) that the cortical pulsations become negligible if volume changes of the exposed brain are prevented by sealing over the opening in the skull with a rigid cover, such as a glass window, and filling the space underneath with liquid. A chamber formed in this manner would be useful for extracellular or intracellular recording if a microelectrode could be brought inside the enclosure through a movable liquid-tight joint.

Li and Jasper have employed this principle for microelectrode recording in the cortex (*2*). They used a chamber with which the microelectrode could be located over a single spot on the cortex and with which the depth of insertion into the cortical tissue could be controlled by a separately mounted micromanipulator.

A somewhat different approach has been adopted in the chamber described here, which is a modification of one used for the study of oxygen gradients at the cortical surface (*3*). In this chamber, as shown in Fig. 1, a small micrometer drive for controlling the depth of insertion of the electrode is directly mounted on the glass window, which is movable. Thus the electrode, which is mounted in the shaft of the microdrive (*4*), may be located over any desired point on the exposed cortex, without opening the chamber, by sliding the window manually. The mode of attachment of the microdrive also gives more stability than would be obtained if its mounting were independent of the skull.

Although it is designed for electrophysiological work on the cortex, the chamber employs a novel form of microdrive that would be useful in many other situations. The rigid attachment of the micrometer to a movable glass plate allows micromanipulations to be performed with good visibility and mechanical stability inside a completely closed chamber. This would be useful, for example, in such fields as chick-embryo work (with shell intact), tissue-culture work in general, or in physics and engineering where micromanipulations in vacuum chambers are necessary.

As Fig. 1 shows, the wall of the chamber consists of a Plexiglas ring attached to the skull around a ½ in. trephine hole by means of a dental impression compound. The ring is ⅜ in. high, a height sufficient to permit observation of the microelectrode tip with a dissecting microscope at as small an inclination from the vertical as practicable. Two side tubes, normally closed, serve for introducing either a 0.9-percent NaCl solution or paraffin oil. The window, which forms the top of the chamber, is a circular glass disk 1¼ in. in diameter; it is made from a microscope slide and has a hole in its center for mounting the microdrive. A two-pronged spring fork serves to keep the disk pressed against the Plexiglas ring. The prongs of the fork are not attached to the microdrive, but they touch the disk at points over the ring. Leakage at the joint between the glass and the machined surface of the ring was prevented by melting a thin layer of the dental impression compound to the top of the ring and molding it flat with a hot, wet microscope slide. The window could still be moved, but it was leakproof.

The microdrive is made entirely of stainless steel, with the exception of the setscrew and key. For those parts that are in contact with the liquid in the chamber, it is preferable to use 18-8 SMO stainless (*5*). The barrel is sealed to the glass disk with DeKhotinsky cement and is secured mechanically with a nut. The shaft is made of 18-gage stainless steel hypodermic tubing; it fits closely into the barrel, forming a bearing with a nominal clearance of 0.0001 in. The bearing is made liquid-tight by a lubricant with a viscosity that is intermediate between that of Vaseline and beeswax.

The advancement of the shaft is indicated by a lower pointer, which shows the number of turns of the thimble, and an upper pointer, which indicates fractions of a turn. The pitch of the thread on the barrel is 1/64 in. The lower end of the thimble has four longitudinal slots for adjusting thread tension in order to

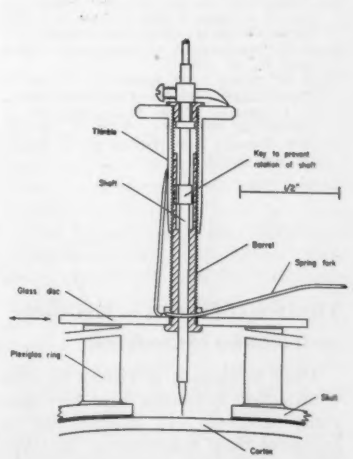

Fig. 1. Cortical chamber with attached microdrive.

eliminate backlash. Rotation of the shaft is prevented by a spring-loaded phosphor-bronze key which is soldered to the shaft and which engages a longitudinal slot in the barrel. There is a tendency of the upper end of the shaft to bend sideward slightly when the thimble is turned, producing a rotation about the slot as fulcrum or center. This is prevented by a washer (not shown in Fig. 1) that fits the shaft snugly and is soldered to the top of the barrel after the shaft has been inserted. End-play of the thrust bearing at the top of the thimble can be adjusted by means of the setscrew in the upper pointer. The total backlash of the thimble owing to this source and to looseness of the thread can be kept down to 15 μ without causing stiffness.

The chamber has been used in the department of physiology at Johns Hopkins University for studies of the first auditory and first somatic areas of the cerebral cortex of the cat (*6*). When the electric activity of a single neuron has been isolated, it is usually possible to record the activity as long as desired, although tests of this point beyond a few hours have not been made. On a few occasions, ball-and-socket joints have been made in the Plexiglas ring for introducing either gross electrodes for recording and stimulating or a cannula for local perfusion of the cortex. A later model of the microdrive has been made with a metric thread of ½ mm pitch.

PHILIP W. DAVIES

Department of Biophysics, Johns Hopkins University, Baltimore, Maryland

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23 April 1956

Elevation of Platelets in Mid-Cycle: an Indication of Ovulation

Three methods to determine the time of ovulation in women have been generally accepted: (i) interpretation of graphs of basal temperature; (ii) cytologic examination of vaginal fluid; (iii) endometrial biopsy. Changes in the genital tissues would be expected to be delayed until after rupture of the Graafian follicle, whereas systemic reactions such as temperature elevation or alteration of blood elements might be expected to give a more prompt indication of ovulation. During a prolonged study of a female patient with essential thrombocytopenic purpura, it was observed that the platelets consistently reached their highest levels during ovulation, as determined by basal temperature graphs (*1*).

The present study (*2*) was concerned with variations in platelet levels during repeated menstrual cycles and with correlation of these platelet levels with the time of ovulation, as determined by basal temperature records. Twenty-six young women were studied. Twenty had normal cycles, four had been oophorectomized, and two were pregnant. Nine hundred seventy platelet counts (*3*) were done during 78 menstrual cycles for a 6-month period. Daily oral temperature recordings were kept by each woman. Daily platelet counts were performed in nine women for at least one complete menstrual cycle, and in the remainder of the women approximately 15 counts in each cycle were done mainly during menstruation and during the mid-cycle. Fifty-one cycles were complete and considered adequate for analysis.

The platelet levels in the 26 women varied from 70,000/mm³ to 462,000/mm³ with a mean of 217,000/mm³. Fluctuations of platelet levels from day to day ranged from 5000 to 30,000 in 46 cycles. In five cycles, however, the changes were considerable, varying from 40,000 to 80,000 from day to day, excluding ovulatory peaks and menstrual dips.

Following menstruation, the platelets either remained constant or rose gradually during the next 2 weeks (Fig. 1). In mid-cycle, the levels usually rose suddenly and dramatically within 24 hours, reaching the highest point during the entire cycle. Within another 24 hours, the platelets returned to their previous levels. In some cycles, this acute rise and fall of platelets was as high as 140,000. In nine cycles (17.7 percent) of eight patients, the platelet levels rose gradually and less dramatically during 2 to 3 days but always reached a peak during mid-cycle.

After the mid-cycle rise and fall, the platelet levels remained constant or decreased gradually until the onset of the next menstrual period and were lowest on the first or second day of the menstrual period. The platelets were found to be at equal levels on the first and second days of menstruation in 38 cycles (74.5 percent).

When the platelet levels were correlated with basal temperature graphs during the same menstrual cycle of patients with biphasic temperature records, the highest point of the thermal shift was found to coincide with the highest elevation of the platelets in 22 cycle (43.1 percent). In four cycles (7.8 percent) the platelets reached their highest values at the time of the temperature dip, whenever such a temperature drop was present. In nine cycles (17.7 percent) where no temperature dip was noted, the platelet peak occurred 24 hours before the temperature reached the highest eleva-

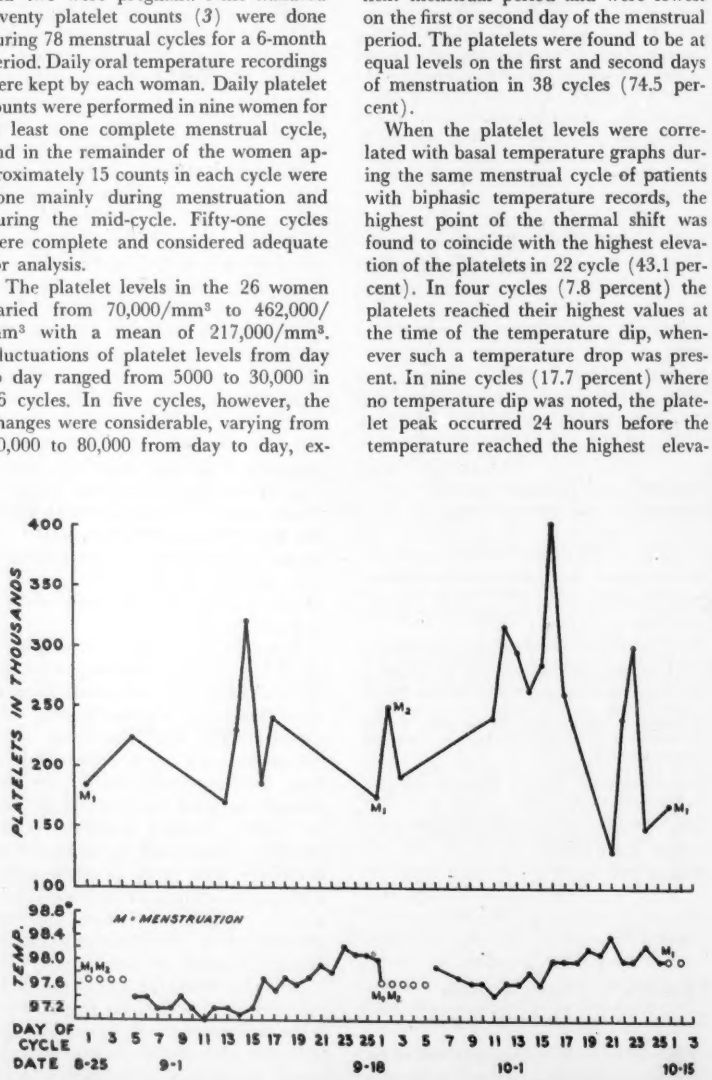

Fig. 1. Platelet levels and basal temperature during two successive biphasic menstrual cycles.

Table 1. Platelet levels in normal, oophorectomized, and pregnant women.

	Normal			Oophorectomized	Pregnant
	Control	Ovulation	Menstruation		
Number	537	49	140	95	19
Range	100,000–390,000	230,000–430,000	100,000–380,000	70,000–400,000	120,000–290,000
Mean	217,000	303,000	215,400	186,400	190,200
Standard deviation	±49,200	±53,800	±53,400	±60,200	±51,200

tion. Therefore, in 35 cycles (68.6 percent) the platelet peaks coincided with the temperature shift from the low to the high phase. In nine cycles (17.7 percent) the platelet values were highest 24 hours after the temperature shift. In four cycles (7.8 percent) the platelet peaks followed the temperature shift by 48 to 72 hours, and in three cycles (5.9 percent) the platelet peak preceded the temperature shift by 48 to 72 hours. Thus, in 86.3 percent of cycles the platelet peak occurred during the thermal shift or within the following 24 hours.

Two women recorded both monophasic and biphasic temperature graphs. In the biphasic cycles, the platelet peaks coincided with the temperature shift. When the temperature graphs were monophasic, generally assumed to indicate an anovulatory cycle, the platelets also reached a peak during the mid-cycle, a finding suggesting that ovulation may have occurred. In four cycles, *Mittelschmerz* occurred in mid-cycle on the day of the platelet peak. Four oophorectomized and two pregnant women showed no cyclic pattern of platelet counts done daily or bidaily.

The ranges, mean values, and standard deviations of the platelet counts during the ovulatory peaks and during the menstrual dips were determined. The same was done with the remainder of the platelet counts which were considered control values (Table 1). There were no significant differences between the control values and those during menstruation. Although there were no significant differences between the control levels and those of pregnant women ($T = 1.62$, $P = 0.25$), the control levels of normal women were significantly higher at the 5-percent level ($T = 3.65$, $P = 0.05$) than those of oophorectomized women. The ovulation levels were significantly higher at the 1-percent level ($T = 7.96$, $P = 0.015$) than the control levels.

It has been generally accepted that the basal temperature shift from the low to the high phase is indicative of ovulation and that ovulation may immediately precede or follow the temperature shift. Since the platelet peaks occurring in every mid-cycle were sharp and were usually characterized by a sudden rise in a 24-hour period, platelet levels may be of greater value in establishing the time of ovulation than the basal temperature graphs, especially when the temperature shift to the high phase is gradual and prolonged for several days. The close association of the platelet peaks and the temperature shift suggests that the platelet peak may be coincidental with ovulation in the vast majority of menstrual cycles. Platelet levels are currently being determined in a number of sterile patients, and intercourse or artificial insemination are planned to coincide with the platelet peaks in mid-cycle.

HERMAN PEPPER
Sequoia Hospital,
Redwood City, California
STUART LINDSAY
Department of Pathology,
University of California
School of Medicine, San Franciso

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12 April 1956

Multiple Glaciation since the Ice Age

The proposal that there has been a number of distinct glacial periods since the retreat of the Wisconsin glaciation is relatively new (*1*), although moraines corresponding to an age older than our present glaciers, but younger than Wisconsin age, have been recognized for some time (*2*). It is the purpose of this report to acquaint others working in this field of study with the availability of a tremendous amount of unevaluated data on this subject in the Sierra Nevada Range in California.

The existence of moraines a few thousand feet down-valley from some of the ice-cored moraines in the Sierra Nevada, but several miles up-valley from the nearest Wisconsin moraines, was recognized in 1949 (*3*). The significance of these moraines did not become apparent until 1951, when the same pattern of a series of moraines a short distance below the ice-cored moraines was observed at two glaciers on the north side of Dana Plateau, just outside Yosemite National Park. The interesting observation was the similarity between the modern, ice-cored moraines associated with the advances during the last 5 centuries (*4*) and the pattern of the older moraines in the canyon a short distance below. A series of closely spaced morainal loops suggested that the earlier glaciation had followed the same pattern as the present glaciation, with a number of advances of almost equal intensity.

Inspection of a collection of aerial photographs (*5*) of the Sierra Nevada crest from Mount Conness to the Middle Palisade indicates that this pattern of multiple glaciation since the ice age is typical of the Sierra Nevada. This conclusion seems unquestionable after stereoscopic examination of approximately 300 of an estimated total of 500 cirques for the entire range, most of which contain moraines with the characteristic form and appearance that indicates the presence of an ice core. The cirques usually contain active glaciers or small ice accumulations indicative of recently extinct, modern glaciers. Older moraines, distinctly separate from the modern ice-cored moraines, occur in 94 of these cirques. In 28 additional cirques, the older moraines are present, but modern ice-cored moraines are either absent or their existence is doubtful. It is likely that the percentage of cirques containing older moraines is higher than indicated, for many may exist which cannot be identified in the aerial photographs.

The criteria used for estimating that the second group of moraines is older than the group of modern, ice-cored moraines are their form, appearance, and position with respect to ice-cored moraines. The latter are readily identified by their fresh appearance, thickness, evidence of instability and avalanching at their margins, proximity to an active glacier, or similarity in appearance to other moraines that can be identified with little doubt. Only two of the older moraines have actually been inspected in the field by me. Their stratigraphy or the development of soil profiles has not been studied, although there is soil and plant growth on one of the two moraines visited.

Two cirques near Mather Pass in the southwest corner of the Bishop (California) quadrangle have three distinctly different sets of moraines, including modern, ice-cored moraines. Other cirques at Ragged Peak and Mount Wallace have two sets of moraines of apparently different ages, and the youngest of the moraines do not appear to have any ice core. The cirques are partially filled with talus. Crandell and Waldron (*6*) report moraines of three different ages at Emmons Glacier on Mount Rainier, Wash-

ington. I have observed moraines of three different ages at Carbon Glacier, Mount Rainier, and moraines of two separate periods of comparable intensity at the Nisqually Glacier.

The tentative interpretation of this evidence suggests that at least two periods of glaciation occurred in this country before the most recent advance and that the age of these glaciations is more than 500 years and probably no older than the Cochrane advance in Canada.

A. E. HARRISON
Department of Electrical Engineering, University of Washington, Seattle

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4 June 1956

Penetration of Slow Electrons through Spore Walls of Bacillus megaterium

Electrons in the energy range of from a few hundred to a few thousand electron volts serve as a probe for studying surface features of biological organisms (*1*). The work described in this report was undertaken to study the coats of spores of *Bacillus megaterium* by slow-electron bombardment (*2*). The apparatus used was that described by Davis (*3*), who studied spores of *Bacillus subtilis*.

Electrons from a hot tungsten filament, which are accelerated by voltage from a variable power supply, strike the dry spores on a stainless-steel disk in an evacuated bombardment chamber. Subsequently, the disk with 12 bombarded samples and four controls is layered with nutrient agar and incubated for 6 hours or more. Colonies formed by the surviving spores are counted under a low-power microscope, and the number of colonies in a bombarded sample compared with the number of those in controls on the same disk is taken as the survival ratio. The rate of electron flow from disk to ground, which is indicated by a galvanometer, is held constant, so that the dose, in electrons per unit area, can be calculated from the time of exposure and the area bombarded.

Table 1. Dose in electrons per square micron for 37-percent survival of *B. megaterium* spores as a function of voltage.

Volts	Dose (10^3 electrons)
800	270,000
1000	30,000
1200	8,000
1400	1,600
1600	800
1800	500
2000	300
2200	150
2600	30
2800	30
3000	14
3200	8
3400	7

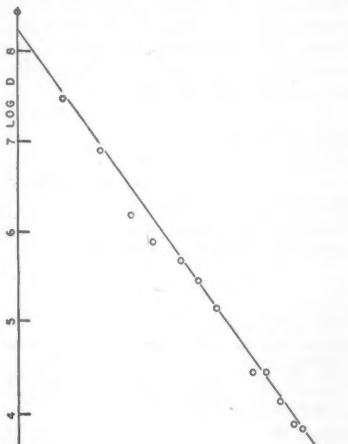

Fig. 1. Log dose in electrons per square micron for 37-percent survival versus log voltage. The line is represented by the equation $DV^{7.26} = 10^{29.38}$.

The percentage of survival was plotted on a logarithmic scale as a function of dose, with voltage as a parameter. The points generally lay on straight lines typical of single-hit killing except that, at the lower voltages and below about 10-percent survival, points were obtained on a second straight line with a smaller slope than the first. The presence of bacterial debris on a small fraction of the spores might be inferred from their survival in spite of a large dose.

Bombardments were made at 200-v intervals from 400 to 3400 v. From the plotted survival curves, the 37-percent survival dose D, in electrons per square micron, was found for each voltage V. Typical data are presented in Table 1.

Inspection shows that, on a plot of log D versus log V (Fig. 1), the experimental points lie rather close to a straight line represented by the equation, $DV^{7.26} = 10^{29.38}$. The interpretation offered is that this function represents the probability of electron penetration through the spore wall with enough residual energy to produce a fatal ionization. At the highest voltage used, about 7000 electrons strike a square micron, which is the order of magnitude of a cross-sectional area of a spore. The portions of the spore that are sensitive to killing by ionization, assumed to be distributed at random inside the spore wall, appear to occupy an area of about 1.4×10^{-4} μ^2 each.

The absorption of 600- to 2000-v electrons has been studied by Davis (*4*) in invertase for comparison with theoretical values for tissue which were calculated by Lea (*5*). In neither case was the probability of penetration expressed as a function of electron energy, but their results indicate that the spore wall in the experiments reported here probably has a thickness of about 0.15 to 0.2 μ. The lower value is in better agreement with electron-microscope pictures of spore sections obtained by Robinow (*6*), which themselves must be interpreted in the light of possible dimensional distortion by the treatment required to prepare the specimens for the electron microscope.

HAROLD P. KNAUSS
Department of Biophysics, Yale University, New Haven, Connecticut

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2. This work was done at Yale University while I was on sabbatical leave from the University of Connecticut, Storrs. I wish to express thanks for the many courtesies extended.
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15 May 1956

There was nothing wrong with the old inference that if I know all about the present I can forecast the future exactly; the trouble was the impossibility of knowing the present. Once this is seen, the whole argument becomes obvious, but nobody saw it until Heisenberg.—C. G. DARWIN (*1938*).

Book Reviews

Les Dislocations et la Croissance des Cristaux. Willy Dekeyser and Severin Amelinckx. Masson, Paris, 1955. 184 pp. Illus. F. 2000.

This book is a simple and excellent account of the recent fundamental advances in the field of crystal growth, since the recognition by F. C. Frank of the preponderant role of dislocations in it. The beginning of this development occurred nearly 10 years ago at the University of Bristol, in England. I had the privilege to watch and become associated with the nucleation and growth of this idea, today so simple that it appears obvious, although it was clearly not so at the time. The further contributions to the field of solid state from its author, F. C. Frank, are certainly of paramount importance, but his foresight and bold imagination are nowhere as apparent as in his prediction that dislocations should control the growth of crystals.

The theory of dislocations, as well as their role in most of the aspects of solid-state physics, has been covered recently in several books and reviews. Among the books one should mention are those by Read, where the geometric aspects of dislocations are developed, and the book by Cottrell, where their importance in the plastic flow of crystals is emphasized. The review by Seeger, in the *Encyclopedia of Physics*, treats the more recent developments of the general theory of dislocations.

None of these, however, covers properly the application of dislocation theory to crystal growth. There exist reviews by Frank and Forty, and also the book by Verma, but no attempt had previously been made to put together the entire field. This is very properly done by the work under review, in a very simple style particularly suitable for beginners. The book, no doubt, will help in filling the gap separating crystallographers from solid-state physicists.

The experimental development of the work has been carried out mainly by two groups, one working in England under the guidance of Frank himself and including Forty and Verma. The book under review was written by the second group, working at the University of Gand, Belgium, under the direction of W. Dekeyser and S. Amelinckx. Their contributions have been outstanding, and it is therefore entirely proper that they should have written a book on the entire subject.

The first chapter in the book concerns itself with an elementary introduction to dislocation theory. This chapter does not compare, of course, with Read's account, the intention being to give the necessary background to understand the role of dislocations in crystal growth.

In the initial sections of Chapter II, an account is given of the multiple attempts to interpret the form of crystals in terms of a more or less empirical theory of their growth. It is astonishing what a tremendous amount of work has been done on this apparently simple question, without a simple answer having been found. This part of the book is useful in that it gives most of the earlier references pertaining to the subject; it is, however, disappointing in not giving a critical account of them. It is true that, even today, the question is still a puzzling one; however, it is so, not because we are missing some fundamental idea, but because it is an exceedingly complicated question. The other sections of this chapter give a lucid and short account of the paper by Burton, Cabrera, and Frank, where the theory was first presented.

Chapter III is very useful to anybody interested in this type of work, because it gives a résumé of the modern optical methods (phase contrast, and so forth) that have contributed so much to the testing of the predictions of dislocation theory.

The four following chapters form the core of the book. They describe the two more outstanding contributions of dislocation theory in relation to the growth of crystals: the explanation of the detailed spiraling configuration of steps on growing crystal faces, and the understanding of the phenomenon of polytypism. The authors have made considerable contributions to both of these questions, so it is not surprising that their discussion is excellent. These chapters are very welcome, for there is no other general account of this part.

In the final two chapters, VIII and IX, a description is given of the formation of etch pits at dislocations and of the growth of whiskers, and finally a discussion of the possible ways for dislocations to be produced in a crystal during its growth. There is considerable work going on in the former problems, and a lot of speculation is being advanced to account for the latter; hence, the book could not be expected to give a complete picture of both of these subjects.

On the whole, this book is a very valuable contribution to the field; its clarity and simple presentation will appeal to young workers who might become interested in this field. The only general criticism one might advance is that, although they discuss and criticize thoroughly their own work, the authors seem to have a tendency to limit themselves to a detailed description of that of other people without a severe criticism. It is very unfortunate that there was so much delay in the publication of this book. It would have been much more helpful if it had become available in the English-speaking countries a couple of years ago.

NICOLAS CABRERA
Physics Department,
University of Virginia

Advances in Food Research. vol. VI. E. M. Mrak and G. F. Stewart, Eds. Academic Press, New York, 1955. xii + 398 pp. $9.

This volume, like the preceding volumes in the series, reviews and discusses timely and significant scientific and technologic aspects of foods. There are seven articles, and they range in length from 22 to 76 pages. These cover five commodities and three functional areas—namely, applications of research to problems of candy manufacture; bacterial spoilage of wines with special reference to California conditions; microbiological implications in the handling, slaughtering, and dressing of meat animals; microbiological problems of frozen food products; potato granules, development and technology of manufacture; the thermal destruction of vitamin B_1 in foods; and tunnel dehydrators for fruits and vegetables. Each article is well organized, accurately written, and accompanied by a comprehensive bibliography. There are approximately 1800 references, and the titles are included in six of the reviews. The effective use of the volume is enhanced by the inclusion of an author index. The subject index is rather incomplete.

There are ten authors, and six of them are connected with two of the regional research laboratories of the U.S. Department of Agriculture. Only one is employed by a food-manufacturing com-

pany, and only two are members of educational institutions. Most of the authors have published extensively in their fields of specialization.

Some of the chapters are obviously companion articles for reviews in some of the earlier volumes of this series. For example, the chapter on the production of potato granules is a logical and timely follow-up of the general article in volume I on the deterioration of processed potatoes. Also, the chapter on tunnel dehydrators for fruits and vegetables extends the collected information on the spray-drying of foods that appeared in volume II of *Advances in Food Research*.

The reviews are remarkably free from errors, as determined by one reading, and all the authors appear to have covered nearly every aspect of their topics concerning which there exists any published knowledge. Thus, the volume provides an excellent source of dependable and well-documented information. Moreover, in most of the reviews the need for additional knowledge or interpretation of existing information is pointed out. Thus the articles have been written critically, and they are more than compilations of published data.

This volume should be of value to all persons who are concerned with food research and technology.

HARRY G. DAY
Department of Chemistry,
Indiana University

Essays in Biochemistry. Samuel Graff, Ed. Wiley, New York; Chapman & Hall, London, 1956. 345 pp. Illus. $6.50.

These essays were written in honor of Hans Thacher Clarke on the occasion of his retirement as professor and chairman of the department of biochemistry, College of Physicians and Surgeons, Columbia University. The authors were either Clarke's former students or academic associates, and in their contributions they academically express their affection and esteem for his excellent help as well as for his generous aid and wise counsel. These scholarly essays reflect in large measure the high standards of excellence instilled in the authors by their teacher and associate.

This book is divided into 25 chapters. In the prefatory remarks it is stated that some of the chapters are critical discussions of the status of biochemical problems, whereas others are frankly speculative or deliberately provocative. A wide range of subjects is included: metabolic products of basidiomycetes (Marjorie Anchel), heterogeneity of DNA (Aaron Bendich), biosynthesis of branch-chain compounds (Konrad Bloch), lysogeny (Ernest Borek), plasma volume expander (Max Bovarnick and Marianna R. Bovarnick), conjugated proteins (Erwin Chargaff), thymine metabolism (Seymour S. Cohen), steroid hormones (Lewis L. Engel), bacterial viruses (E. A. Evans, Jr.), peptide bonds (Joseph S. Fruton), on the nature of cancer (Samuel Graff), lipide metabolism (Samuel Gurin), tetrazoles as carboxylic acid analogs (Robert M. Herbst), structural basis for the differentiation of identical groups in asymmetric reactions (Hans Hirschmann), nitrogen-sparing effect of glucose (Henry D. Hoberman), inositol in microorganisms (Boris Magasanik), ferritin (Abraham Mazur), nitrogen transfer in biosynthetic mechanisms (Sarah Ratner), bigness of enzymes (David Rittenberg), biosynthesis of porphyrins (David Shemin), role of carbohydrates in the biosynthesis of aromatic compounds (David B. Sprinson), determining chemical structure of proteins (William H. Stein), glycogen turnover (DeWitt Stetten, Jr., and Marjorie R. Stetten), veratrum alkamines (Osckar Wintersteiner), and the chemical basis of heredity determinants (Stephen Zamenhof). Herein lies a good education in molecular anatomy and molecular physiology.

Several of the statements in this book are really speculative and/or provocative, and they are couched in rather good syntax so that they could engage a person's thoughts for more than a fleeting moment. There is a vast storehouse of information as well as questions left without answers in this book. All the chapters are stimulating, and I think they will present some new ideas that the reader may wish to consider. Clarke will be pleased with the excellence of this volume, and the contributors will likewise be congratulated for the painstaking job they have performed in organizing and writing their chapters. The thought-perplexing questions raised by Clarke's former students and associates will engage the labors of a whole decade of biologists.

JOSEPH T. VELARDO
Department of Anatomy,
Yale University School of Medicine

Sites of Infection. Unstable areas as sources of parasitic diseases; schistosomiasis and fascioliasis. Alan Mozley. Lewis, London, 1955. x + 86 pp. Illus. 9s.

The author has attempted to make an ecological analysis of the conditions conducive to the establishment and maintenance of certain parasitic diseases of man and domestic animals in which the parasites utilize snails as intermediate hosts. He concerns himself in his discussion chiefly with liver-rot of cattle and sheep and with bilharzia (urinary schistosomiasis) of man. His emphasis is on the ecological instability of the places in which dangerous snails live.

In frontier areas it may be possible to effect control by allowing the natural forces to stabilize into a condition where parasite-carrying snails are reduced to very small numbers. In irrigation systems and other bodies of water that are created and maintained by man, these natural forces are interrupted with the result that control must then be achieved through the use of chemicals for killing the snails. It would seem that the ecological approach followed in this treatise might be profitably applied to other parasitic and tropical diseases.

C. G. HUFF
Naval Medical Research Institute

Suggestion and Hypnosis in the Light of the Concepts of I. P. Pavlov. A popular science survey. K. I. Platonov. State Publishing House of Medical Literature, Moscow, U.S.S.R., 1951. 56 pp. Illus. (In Russian).

This booklet, although described as a popular science essay, is actually limited in its appeal and comprehensibility to a college-trained and science-oriented audience. The author, K. I. Platonov, a student of I. P. Pavlov, has had extensive experience in clinical and laboratory investigations of hypnotherapy and appears well qualified to discuss this subject.

Platonov's chief thesis is that hypnosis is nothing more than partial sleep induced by factors that, under proper conditions, will also produce normal sleep. Sleep is considered as a protective inhibitory state originating in the cerebral cortex and eventually spreading to subcortical areas. The author, therefore, concludes that hypnosis, like natural sleep, cannot be considered to have harmful potentialities, certainly not when it is induced by properly trained physicians.

The exaggerated power of suggestion during hypnosis is viewed simply as one example of the use of words as conditional stimuli belonging to the so-called "secondary signal system." The author reviews briefly Pavlov's classification of conditional stimuli: (i) those belonging to the primary signal system, that is, stimuli affecting directly the sense organs (these signals are shared by man and animals); (ii) those belonging to the secondary signal system (words) which are characteristic for man alone. Since this secondary signal system exerts its effects via the primary signal system, the author

suggests that the secondary signal system must be subject to the same laws that govern the primary signal system.

The book presents a brief review of the development of hypnosis with particular emphasis on clinical and laboratory investigations conducted in Russian medical institutions.

Platonov suggests the consideration of using hypnotherapy for two purposes: (i) as a method of providing patients with the protective benefits of rest for the cerebral cortex, without necessarily using suggestion; (ii) the use of hypnosis with suggestion. The author describes numerous experiments and clinical observations on the effects of hypnosuggestion on various visceral and somatic functions. Several case histories are cited.

It is suggested that hypnotherapy shows promise of being useful in achieving painless childbirth; in treating certain cases of persistent vomiting (especially in pregnancy); in dermatology; as adjunct therapy in pulmonary tuberculosis; and possibly in some cases of hypertension and peptic ulcer.

SAMUEL A. CORSON
Department of Physiology and Pharmacology, University of Arkansas School of Medicine

Progress in Biophysics and Biophysical Chemistry. vol. 6. J. A. V. Butler, Ed. Pergamon Press, London, 1956. 274 pp. $9.50.

In the preface to this volume the editor comments that this "may be a convenient point to look back to see how far the aims of this series, as stated in the original preface, have been achieved." These aims were to provide critical reviews—"excluding biochemistry on the one hand and physiology on the other, there lies between a vast and rather amorphous field of study of which the frontiers and lines of demarcation are anything but well defined"—of biophysics. With these aims one can hardly disagree, but it is a good deal easier to ask for, than it is to write, critical reviews, and few of the papers included in this volume can be considered critical. Rather, it is easier for a particular author, who has developed a theoretical framework within which he can explain many of the experimental observations in his field, to find in the literature support for such views. This is not necessarily a disadvantageous situation, since it is likely that a great deal more in the way of information will be necessary in many fields of biophysics before critical reviews will be possible.

With the necessarily broad definition of biophysics that is given in the preceding paragraph, it is not possible to criticize the topics selected for review on a subject-matter basis, but it does seem implicit in the definition that if we are to exclude biochemistry and physiology, what is left should at least be amenable to quantitative treatment: on this score, three out of seven contributions are clearly of a purely descriptive nature. This may be a reflection of the difficulty in obtaining 250-odd pages of biophysics reviews a year, surely a formidable task.

The first paper, entitled "Protamines and nucleoprotamines," by Felix, Fischer, and Krekels, is a biochemical paper with extensive treatment of the preparative aspects of the subject but with little in the way of an evaluation of the possible connection between protamines and nucleic acids. A second paper on "The structure of chromosomes," by Ambrose, is, again, a purely descriptive account of, largely, the cytological aspects of chromosome morphology, and one searches in vain for a biophysical connection.

The third contribution, "The Donnan equilibrium," by Overbeek, is a rigorous and detailed treatment of the system and leads to the conclusion that in biological systems little error is likely to result from the use of the classical approach. This paper is valuable in that it helps to clarify some of the confusion that has arisen in the measurement of Donnan potentials, and it appears very desirable to have reviews of topics in physical chemistry that are involved in explanations of biological phenomena. The next paper, "Biology and biophysical properties of transforming principles," by Zamenhof, is again a purely descriptive account of a rather mysterious (but often reviewed) phenomenon and one that does not at present lend itself to quantitative treatment.

The fifth paper, "Biophysical aspects of neuro-muscular transmission," by Del Castillo and Katz, is perhaps the most coherent and detailed account of a rather complicated phenomenon in the volume. The authors have the great advantage that transmission problems have occupied the attention of physiologists for a considerable period of time, and further, much of the recent progress in this field has been made in their own laboratories. This is not to imply that the story has been fully worked out, or even that all parts of the experimental observations are equally well explained. In particular, explanations regarding miniature end-plate potentials, resting as they do largely on pharmacological grounds, seem much less attractive than those regarding, for example, the ionic basis of the end-plate potential.

"Models for biological excitation processes" by Franck is the next paper in the volume. I can develop little enthusiasm for the view that iron wire models are at all helpful in understanding excitation processes, in spite of a serious effort by the author to show that this is so. At least three-quarters of the references cited were published prior to 1950. The last paper, "Physical aspects of the sense organs" by deVries, is an attempt to treat a variety of topics in sensory physiology; these appear to have been selected rather at random—a page on taste and smell, a detailed treatment of the labyrinth, and a few topics on vision. Many of these notes are interesting, but, in general, one might wish for a more systematic discussion.

L. J. MULLINS
Biophysical Laboratory, Purdue University

Some Extinct Elephants, Their Relatives and the Two Living Species. Ceylon National Museums Publication. P. E. P. Deraniyagala. Ceylon National Museum, Ceylon, 1955. 161 pp. Illus. + plates. $3.

The fascination of elephants is great and endless. Those who feel this fascination can turn to P. E. P. Deraniyagala, director of the Ceylon National Museums, for its rich gratification. Here is a remarkable miscellany of elephant lore and observation, ancient and recent.

There is solid reference value in extensive tabulations on the hitherto rather neglected and obviously difficult subject of variation in elephants: Thirty-five points of the elephant's body are illustrated, with their Sinhala names and English translations. No less than 90 "nerve centres" or *nila* are similarly illustrated; these are points where pressure by the mahout with an ankus directs and controls the elephant. The book is further replete with bits of curious and unexpected information, a rapid sampling of which includes nine ways in which elephants kill human beings, the use of elephants in arena combats, detailed descriptions of parturition, instructions for catching wild elephants, expense accounts of elephant hunts in the last century, the medieval Sinhala breeds of elephants, lucky (such as eyes like a sparrow) and unlucky (such as eyes like a cobra) characters of elephants, and a recipe for fattening baby elephants.

Detailed treatment refers mainly to the elephants of Ceylon, but all Asiatic elephants are characterized at least briefly. An introductory section gives a partial classification of the Proboscidea and a new arrangement of the Elephantidae as well as scattered observations on various fossil proboscideans and on African elephants. Some of this work is open to criticism as being more appropriate in a technical reconsideration than in this

general review. A rather odd nomenclatural problem posed by Deraniyagala may be mentioned. He has used several artistic representations, not actual specimens, as types of subspecies. Indeed, there seem to be no known specimens of *"Elephas maximus rubridens,"* the type of which is "an antique bronze statue."

There are numerous photographic illustrations, several maps, and some spirited drawings by the author, including one of his own narrow escapes from death by an attack of a wild elephant.

G. G. SIMPSON
Department of Geology and Paleontology, American Museum of Natural History

New Books

Man in Search of His Ancestors. The romance of paleontology. André Senet. Translated by Malcolm Barnes. McGraw-Hill, New York, 1956. 274 pp. $5.50.

Proceedings of the First International Photobiological Congress (4th International Light Congress). Amsterdam, 23–28 Aug. 1954. Veenman & Zonen, Wageningen, Netherlands, 1956. 472 pp. $8.50.

Engineering Problems. Charles A. Hutchinson, Leon Watson Rutland, Jr., Walter W. Varner. Harper, New York, 1956. 179 pp. $3.

A History of the Therapy of Tuberculosis and the Case of Frederic Chopin. Esmond R. Long. University of Kansas Press, Lawrence, 1956. 71 pp. $2.

Clinical Studies in Psychiatry. Harry Stack Sullivan. Helen S. Perry, Mary L. Gawel, Martha Gibbon, Eds. Norton, New York, 1956. 386 pp. $5.50.

Foundations of Nutrition. Clara M. Taylor, Grace MacLeod, Mary Swartz Rose. Macmillan, New York, ed. 5, 1956. 620 pp. $6.

Dictionary of Latin Literature. James H. Mantinband. Philosophical Library, New York, 1956. 303 pp.

Quantum Field Theory. H. Umezawa. North-Holland, Amsterdam; Interscience, New York, 1956. 364 pp. $9.75.

Special Functions of Mathematical Physics and Chemistry. Ian N. Sneddon. Oliver and Boyd, Edinburgh; Interscience, New York, 1956. 164 pp. $1.75.

Radiation Dosimetry. Gerald J. Hine and Gordon L. Brownell. Academic Press, New York, 1956. 932 pp. $22.

Medicinal Chemistry. vol. II. A series of reviews prepared under the auspices of the Division of Medicinal Chemistry of the American Chemical Society. F. F. Blicke and C. M. Suter, Eds. Wiley, New York; Chapman & Hall, London, 1956. 311 pp. $10.

Polyesters and Their Applications. Bjorksten Research Laboratories, Reinhold, New York; Chapman & Hall, London, 1956. 618 pp. $10.

Random Processes in Automatic Control. J. Halcombe Laning, Jr., and Richard H. Battin. McGraw-Hill, New York, 1956. 434 pp. $10.

Microbiology and Pathology Charles F. Carter and Alice Lorraine Smith. Mosby, St. Louis, ed. 6, 1956. 970 pp. $6.50.

Mathematical Analysis. A modern approach. Walter T. Hamilton and John R. Hamilton. Harper, New York, 1956. 379 pp. $7.50.

Automation, Friend or Foe? R. H. MacMillan. Cambridge University Press, New York, 1956. 100 pp. $1.95.

Industrial Electronics in Questions and Answers. Edward J. Bukstein. Ungar, New York, 1956. 197 pp. $3.95.

Elementary Nuclear Theory. Hans A. Bethe and Philip Morrison. Wiley, New York; Chapman & Hall, London, ed. 2, 1956. 274 pp. $6.25.

General Chemistry. John A. Timm. McGraw-Hill, New York, 1956. 636 pp. $6.

The Analysis of Fantasy. The thermatic apperception technique in the study of personality. William E. Henry. Wiley, New York; Chapman & Hall, London, 1956. 305 pp. $6.

Middleton & Chadwick's A Treatise on Surveying. vol. I, *Instruments and Basic Techniques,* 381 pp.; vol. II, *More Advanced Techniques and Modern Developments,* 438 pp. W. Fisher Cassie, Ed. Philosophical Library, New York, 1956. $20 per set.

The Evolution of the Igneous Rocks. N. L. Bowen. With a new introduction by J. F. Schairer. Dover, New York, 1956. 332 pp. $1.85.

Clays and Clay Minerals. Proceedings of the Third National Conference on Clays and Clay Minerals. W. O. Milligan, Ed. National Academy of Sciences–National Research Council, Washington, D.C., 1955. 573 pp.

Automatic Digital Calculators. Andrew D. Booth and Kathleen H. V. Booth. Academic Press, New York; Butterworths, London, ed. 2, 1956. 261 pp. $6.

Proceedings of the First and Second Conference on Carbon. University of Buffalo, Buffalo, N.Y., 1956. 222 pp. $5.50.

Currents in Biochemical Research 1956. David E. Green, Ed. Interscience, New York, 1956. 697 pp. $10.

Investigation on the Theory of the Brownian Movement. Albert Einstein. R. Furth, Ed. Translated by A. D. Cowper. Dover, New York, 1956. 122 pp. $1.25.

The Principles of Mechanics. Presented in a new form. Heinrich Hertz. Translated by D. E. Jones and J. T. Walley. Dover, New York, 1956. 274 pp. Paper, $1.75.

Traité de pharmacie chimique. vol. I, *Chimie minérale,* 838 pp.; vol. II, *Chimie organique,* série acyclique (composés non azotés), série cyclique (composés non azotés), 1164 pp.; vol. III, *Chimie organique,* série cyclique (composés organiques azotés), série hydroaromatique, série terpénique, stérols et acides biliaires, vitamines, hormones, composés organominéraux, 1194 pp; vol. IV, *Chimie organique,* composés hétérocycliques, matières colorantes artificielles, anthistaminiques, alcaloïdes, 1018 pp.; vol. V, *Chimie organique,* hétérosides, protides, produits divers, antibiotiques, table alphabétiques des vols. II–V, 752 pp. P. Le Beau, Ed. Masson, Paris, ed. 4, 1955–56. 5 vols., cloth, F. 37,000; paper, F. 32,000.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Twentieth Century Fund, Annual Report, 1955. The Fund, New York, 1956. 71 pp.

Units and Systems of Weights and Measures. Their origin, development, and present status, NBS Circ. 570, Lewis V. Judson. National Bureau of Standards, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25). 29 pp. $0.25.

Course Offerings in Guidance and Student Personnel Work, Summer 1956 and Academic Year 1956–57. Circ. No. 476. Compiled by Paul MacMinn. Office of Education, Washington, 1956 (order from Supt. of Documents, GPO, Washington 25). 102 pp. $0.55.

Behavior of Beach Fill at Ocean City, New Jersey. Tech. Memorandum No. 77. George M. Watts. 33 pp. *Hurricanes Affecting the Coast of Texas from Galveston to Rio Grande.* Tech. Memorandum No. 78. W. Armstrong Price. 52 pp. *Orbital Velocity Associated with Wave Action near the Breaker Zone.* Tech. Memorandum No. 79. D. L. Inman and Noriyuki Nasu. 70 pp. *Model Study of Overtopping of Wind-Generated Waves on Levees with Slopes of 1:3 and 1:6.* Tech. Memorandum No. 80. Osvald J. Sibul and Ernest G. Tickner. 27 pp. Beach Erosion Board, Corps of Engineers, 1956.

Magnetic Compensation of Aircraft. Instrumentation for Geophysical Research, No. 4. J. McClay and B. Shuman. 1955. 48 pp. *The Shift and Shape of Spectral Lines.* Geophysical Research Papers, No. 41. R. G. Breene, Jr. 1955. 336 pp. *A Meteorological Analysis of Clear Air Turbulence (A Report on the U.S. Synoptic High-Altitude Gust Program).* Geophysical Research Papers No. 47. Herman Lake. 1956. 63 pp. Geophysics Research Directorate, Air Force Cambridge Research Center, Mass. (order from U.S. Department of Commerce, Office of Technical Services, Washington 25).

Traffic Accidents and Violations. Highway Research Board Bull. 120. 54 pp. $0.90. *Human Behavior in Extreme Situations: a Survey of the Literature and Suggestions for Further Research.* Disaster Study No. 1. Anthony F. C. Wallace. 35 pp. *A Study of Response to the Houston, Texas, Fireworks Explosion.* Disaster Study No. 2. Lewis M. Killian. 25 pp. *Tornado in Worcester.* An exploratory study of individual and community behavior in an extreme situation. Disaster Study No. 3. Anthony F. C. Wallace. 166 pp. National Academy of Sciences–National Research Council, Washington, 1956.

Who Are the Puerto Rican Pupils in the New York City Public Schools? Samuel M. Goodman, Lorraine K. Diamond, David J. Fox. Puerto Rican Study, Board of Education of the City of New York, New York, 1956. 88 pp.

British Scientific Instruments 1956, Directory and Handbook of S.I.M.A. Scientific Instrument Manufacturers Association of Great Britain Limited, London, 1956. 268 pp.

Meetings and Societies

Population

The 1956 annual meeting of the Population Association of America, held at the University of Michigan, Ann Arbor, on 19–20 May, brought together some 160 specialists, students, and others concerned with various aspects of the study of population. Members and guests came from universities and foundations, government agencies, private industry, and from various health and insurance programs. Students from Japan, India, Egypt, and other foreign countries also attended the meeting.

Trends in population growth in various parts of the world were emphasized, as well as the gaps in information regarding population totals for vast areas of the world. T. Lynn Smith reported that 20 Latin American countries, taken together, have the most rapid rate of population increase among any of the major areas of the world. Between 1900 and 1956, Latin American population rose from about 43 million to about 172 million. Waller Wynne, Jr., stated that knowledge of the demographic status of Mainland China is not very great. A 1953 census gave a total of 583 million persons, some 120 million more than the estimates of observers outside Communist China. W. Parker Mauldin and Paul F. Myers pointed to evidence that officials of the U.S.S.R. are using a figure of 200 million as their 1955 population, but that the same figure was utilized for several other years dating back to 1940. The same authors reported that for the Soviet satellites in Europe available evidence points to a population total today about equal to or slightly below that of 1938.

Projecting population trends in India for 30 years under various assumptions, Ansley J. Coale and E. M. Hoover concluded that the total will be about 590 million in 1986 if fertility declines 50 percent during the next quarter century and about 775 million if present fertility remains unchanged. These authors concluded that, in terms of the national economic product of India, the numerous disadvantages of the more rapid rate of growth would probably result in a substantially smaller total national product for the 775 million than for the 590 million.

To increase our knowledge and understanding of the fertility patterns in the United States, a nationwide study is underway. Ronald Freedman and P. K. Whelpton gave a preliminary report on the growth of American families with emphasis upon fecundity-sterility and family-limitation practices. A preliminary report on the findings indicates a high incidence of fecundity impairment. A large proportion of those who use a family-limitation method do not begin to do so until after one or more pregnancies have been experienced. By the later childbearing ages, almost all couples either have a fecundity impairment or use a family-limitation method. These data are being analyzed by age, religion, education, and annual income.

An experiment in population control in Puerto Rico, reported on by Kurt W. Back, Reuben Hill, and J. Mayone Stycos, was an attempt to test and improve a theoretical model in family planning and to introduce experimental methods into field studies of population.

The use of stages of the life cycle as a substitute for age in the study of consumer behavior was discussed by John B. Lansing. Data were presented to show that this classification is more revealing than one according to age for such important economic variables as home ownership, debt, income, and major purchases. Problems of attracting and retaining skilled personnel in the Air Force during a period of high economic activity and limited mobilization were discussed by C. A. McMahon and J. W. Combs, Jr. A paper on population growth, capital-output ratios, and economic development was given by Harvey Leibenstein.

Following the 1950 census, there was an intensive reenumerative check of a sample of the households as part of the evaluative studies conducted by the Census Bureau's technical staff. Morris H. Hansen and Leon Pritzker reported on results and implications of this first Post-Enumeration Survey. There was a net undercount of about 1½ percent in the 1950 Census enumeration. In measuring characteristics, gross differences between the Census and the Post-Enumeration Survey are fairly large, but net differences tend to be small. Plans for the next Population Census of the United States, scheduled for April 1960, were discussed by Conrad Taeuber. Steps under consideration include limiting complete coverage to a smaller number of items than in 1950, and making more extensive use of sampling for other items. Securing information on occupation and industry from a sample of the population commends itself as a means of effecting economies, but consequent loss of some detail in the tabulations may be too great a price.

Other questions are being considered: Is there a feasible alternative to the present rural-urban categories? Should there be changes in definition of urbanized areas and unincorporated places? What changes, if any, should be made in the approach to fertility, family, and marital-status tabulations? What information comparing place of work and place of residence would be most useful? Can less attention be given to the foreign born in view of their declining numbers?

A paper on Standard Metropolitan Areas was presented by the association's president, Henry S. Shryock, Jr., who discussed the evolution, nature, and adequacy of this concept. In general, the Standard Metropolitan Area is a county or a group of counties which contains at least one city with more than 50,000 inhabitants and is a socially and economically integrated unit. Standard Metropolitan Areas have been defined since 1947 by a Federal interagency committee and are widely used for many statistical purposes. While the general criteria for determining these areas should be nationally comparable, there are frequently strong arguments from local interests for a decision that will recognize the "uniqueness" of the situation in a particular area.

HUGH CARTER
SARAH LEWIT
Population Association of America, Washington, D.C.

Meeting Notes

■ A joint committee of members of the Society of Technical Writers and the Association of Technical Writers and Editors has been working on plans for a merger of the two societies into a single, nonprofit, professional organization. The initial plans call for a joint national convention of STW and TWE to be held on 15–16 Nov. at the Hotel Statler in New York. A new constitution will be presented to the joint membership for ratification and adoption after the national convention.

The merger of STW and TWE will result in an organization of over 1000 members with representatives in nearly every state in the United States and in Canada and with chapters in 20 cities

across the two nations. The goal of the combined group will be to aid in advancing the profession by such means as exchanging ideas, establishing standards, and encouraging the training of technical writers and editors.

■ The second Cryogenic Engineering Conference, devoted to engineering problems in the temperature range below 150°K (−190°F), will be held 5–7 Sept., in Boulder, Colo. Technical papers and discussions will cover bubble chambers, instrumentation, properties of materials, insulation, and low-temperature equipment and processes. For information and reservations write to the secretary of the conference committee, P. L. Barrick of the NBS Cryogenic Engineering Laboratory, Boulder, Colo.

■ The first International Cancer Cytology Congress will be held at the Drake Hotel in Chicago, Ill., 8–13 Oct. The congress will be sponsored by the American Society of Clinical Pathologists, the College of American Pathologists, the Intersociety Cytology Council, and the International Union Against Cancer. The first three organizations comprise a combined membership of approximately 3000 scientists. A number of guests from Europe, South America, and Latin American countries are expected to attend as representatives of the International Union Against Cancer. The general theme of the meeting will be exfoliative cytology, although the program will not be devoted exclusively to that subject.

During the congress three of the sponsoring organizations will hold their annual meetings: the College of American Pathologists, the evening of 8 Oct.; the Intersociety Cytology Council, the evening of 10 Oct.; and the American Society of Clinical Pathologists, the evening of 11 Oct. A joint banquet of all organizations will be held on the evening of 9 Oct.

■ The next Cytological Congress will be held at the University of St. Andrews, Scotland, from 28 Aug. to 3 Sept. 1957. Admission will generally be restricted to members of the Society for Cell Biology and their guests. Others wishing to attend should communicate with the secretary of the congress, Prof. H. G. Callan, Department of Natural History, the University, St. Andrews, Scotland. The congress will consist, in part, of a number of symposia and, in part, of sessions at which papers on diverse topics may be read.

Society Elections

■ American Society for Testing Materials: pres., R. A. Schatzel, Rome Cable Corporation; sec., R. J. Painter, 1916 Race St., Philadelphia, Pa. The vice presidents are R. T. Kropf, Belding Heminway Company, and K. B. Woods, Purdue University.

■ Southern Association of Science and Industry: pres., Frank J. Soday, Chemstrand Corporation; sec., George D. Palmer, University of Alabama; treas., Clayton D. McLendon, C. and S. National Bank. The vice presidents are Edwin Cox, Virginia-Carolina Chemical Corporation, and Les M. Taylor, Mississippi Power and Light. Representative to the AAAS Council is H. M. Conway.

■ Gamma Sigma Delta: pres., Louis M. Thompson, Iowa State College; v. pres., Roy L. Lovvorn, North Carolina State College, Raleigh; sec., John A. Johnson, Kansas State College, Manhattan; treas., Homer J. L'Hote, University of Missouri.

Forthcoming Events

August

26–30. American Inst. of Biological Sciences, Storrs, Conn. (H. T. Cox, 2000 P St., NW, Washington 6.)

The following 23 meetings are being held in conjunction with the AIBS meeting at Storrs, Conn.

26–30. American Bryological Soc. (L. J. Gier, Dept. of Biology, William Jewell College, Liberty, Mo.)

26–30. American Fern Soc., annual. (Mildred E. Faust, 501 University Pl., Syracuse 10, N.Y.)

26–30. American Microscopical Soc. (R. W. Pennak, Dept. of Biology, Univ. of Colorado, Boulder.)

26–30. American Soc. for Horticultural Science, annual. (F. S. Howlett, Ohio Agricultural Experimental Station, Wooster, Ohio.)

26–30. American Soc. of Human Genetics. (E. J. Gardner, Dept. of Zoology, Utah State Agricultural College, Logan.)

26–30. American Soc. of Limnology and Oceanography, annual. (B. H. Ketchum, Woods Hole Oceanographic Institution, Woods Hole, Mass.)

26–30. American Soc. of Parasitologists, annual. (A. C. Walton, Knox College, Galesburg, Ill.)

26–30. American Soc. of Plant Physiologists, annual. (A. W. Galston, Dept. of Botany, Yale Univ., New Haven, Conn.)

26–30. American Soc. of Plant Taxonomists, annual. (R. C. Rollins, Gray Herbarium, Harvard Univ., 22 Divinity Ave., Cambridge 38, Mass.)

26–30. Biometric Soc., ENAR. (A. M. Dutton, Univ. of Rochester, Box 287, Station 3, Rochester 20, N.Y.)

26–30. Botanical Soc. of America, an-

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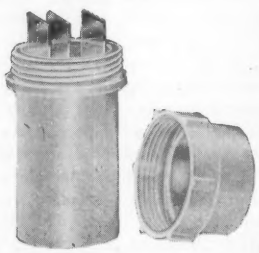

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nual. (H. C. Bold, Vanderbilt Univ., Nashville, Tenn.)

26–30. Ecological Soc. of America, annual. (J. F. Reed, Dept. of Botany, Univ. of Wyoming, Laramie.)

26–30. Mycological Soc. of America, annual. (C. J. Alexopoulos, Dept. of Botany, Michigan State Univ., East Lansing.)

26–30. National Assoc. of Biology Teachers. (P. V. Webster, Bryan City Schools, Bryan, Ohio.)

26–30. Nature Conservancy. (G. B. Fell, 4200 22 St., NE, Washington 18.)

26–30. Phycological Soc. of America, annual. (P. C. Silva, Dept. of Botany, Univ. of Illinois, Urbana.)

26–30. Soc. of General Physiologists. (A. M. Shanes, National Inst. of Arthritis and Metabolic Diseases, Bethesda 14, Md.)

26–30. Soc. for Industrial Microbiology, annual. (C. P. Porter, Dept. of Biological Sciences, Purdue Univ., West Lafayette, Ind.)

26–30. Soc. of Protozoologists, annual. (N. D. Levine, College of Veterinary Medicine, Univ. of Illinois, Urbana.)

26–30. Soc. of Systematic Zoology. (R. E. Blackwelder, 3728 Second St. South, Arlington 4, Va.)

27–29. American Soc. of Zoologists, 53rd annual. (R. T. Kempton, Marineland Research Laboratory, Marineland, Fla.)

27–29. Genetics Soc. of America, annual. (H. B. Newcombe, Atomic Energy of Canada, Ltd., Chalk River, Ont.)

27–31. American Soc. of Naturalists, annual. (B. Wallace, Biological Lab., Cold Spring Harbor, Long Island, N.Y.)

26–1. International Soc. of Haematology, 6th cong., Boston, Mass. (ISH, New England Medical Center, Harrison Ave. at Bennet St., Boston 11.)

27–31. Biological Photographic Assoc., 26th annual, Rochester, N.Y. (BPA, c/o 343 State St., Rochester 4.)

27–31. Electro-Magnetic Phenomena in Cosmical Physics, symp., International Astronomical Union, Stockholm, Sweden. (P. Th. Oosterhoff, University Observatory, Leiden, Netherlands.)

27–31. Infrared Spectroscopy Inst., 7th annual, Nashville, Tenn. (N. Fuson, Dept. of Physics, Fisk Univ., Nashville 8.)

28–2. Colloquium on Semiconductors and Phosphors, IUPAP, Garmisch-Partenkirchen, Germany. (H. Maier-Leibnitz, Walter-von-Dyck-Platz 1, Munich 2, Germany.)

29–2. International Soc. for Blood Transfusion, 6th cong., Boston, Mass. (J. Julliard, 57 Boulevard L'Auteuil, Boulogne-sûr-Seine, France.)

29–5. British Assoc. for the Advancement of Science, annual, Sheffield, England. (Secretary, BAAS, Burlington House, Piccadilly, London, W.1., England.)

29–8. International Soc. of Soil Science, 6th cong., Paris. (F. A. Van Baren, ISSS, Royal Tropical Inst., Mauritskade 63, Amsterdam, Netherlands.)

30–5. American Psychological Assoc., Chicago, Ill. (F. H. Sanford, 1333 16 St., NW, Washington 6.)

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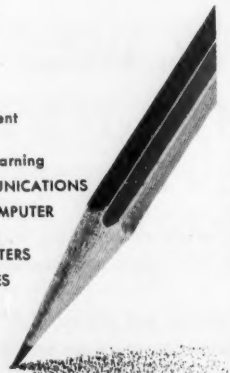

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30–5. Psychometric Soc., Chicago, Ill. (L. V. Jones, Dept. of Psychology, Univ. of Chicago, Chicago 37.)

September

1–9. International Cong. of Anthropological and Ethnological Sciences, 5th, Philadelphia, Pa. (Secretary, American Organizing Committee, International Cong. of Anthropology, National Acad. of Sciences–National Research Council, 2101 Constitution Ave., Washington 25.)

2–7. Laurentian Hormone Conf., AAAS, Mont Tremblant, Quebec, Canada. (Committee on Arrangements, LHC, 222 Maple Ave., Shrewsbury, Mass.)

3–7. Colloquium on Statistical Mechanics of Transport Processes, IUPAP, Brussels, Belgium. (I. Prigogine, 40 Avenue F. D. Roosevelt, Brussels.)

3–10. History of Science, 8th intern. cong., and International Union for the History of Science, 4th general assembly, Florence and Milan, Italy. (Vasco Ronchi, Instituto Nazionale di Ottica, via San Leonardo 79, Florence, Italy.)

4–5. Meteoritical Soc., 19th meeting, Bloomington, Ind. (C. W. Beck, Dept. of Geology, Indiana Univ., Bloomington.)

4–6. International Assoc. of Milk and Food Sanitarians, annual, Seattle, Wash. (H. L. Thomasson, IAMFS, Box 437, Shelbyville, Ind.)

4–7. American Physiological Soc., Rochester, N.Y. (M. O. Lee, APS, 9650 Wisconsin Ave., Washington 14.)

4–9. American Ornithologists' Union, annual, Denver, Colo. (H. F. Mayfield, 2557 Portsmouth Ave., Toledo 13, Ohio.)

4–11. International Geological Cong., 20th, Mexico, D.F. (Congreso Geológico Internacional, Calle Balderas 36, Despacho 302-A, Mexico, D.F.)

4–11. International Paleontological Union, Mexico, D.F. (H. E. Vokes, Johns Hopkins Univ., Baltimore 18, Md.)

5–7. Cryogenic Engineering Conf., Boulder, Colo. (P. L. Barrick, National Bureau of Standards Cryogenic Engineering Laboratory, Boulder.

5–7. Wyoming Geological Field Conf., 11th annual, Moran, Wyo. (K. W. Frielinghausen, Box 1571, Casper, Wyo.)

5–13. International Cong. of Applied Mechanics, 9th, Brussels, Belgium. (H. L. Dryden, Director, National Advisory Committee for Aeronautics, Washington 25.)

6–8. American Political Science Assoc., annual, Washington, D.C. (E. M. Kirkpatrick, APSA, 1726 Massachusetts Ave., NW, Washington 6.)

6–8. Phi Sigma Soc., Ann Arbor, Mich. (K. F. Lagler, Dept. of Fisheries, School of Natural Resources, Univ. of Michigan, Ann Arbor.)

6–12. International Genetics Symposium, Tokyo and Kyoto, Japan. (Secretary, IGS 1956 (Science Council of Japan, Ueno Park, Tokyo.)

7–9. American Sociological Soc., annual, Detroit, Mich. (Mrs. M. W. Riley, ASS, New York Univ., Washington Square, New York 3.)

7–10. American Statistical Assoc., annual, Detroit, Mich. (D. C. Riley, ASA, 1757 K St., NW, Washington 6.)

(See issue of 20 July for comprehensive list)

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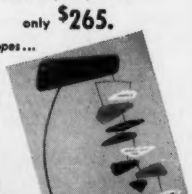

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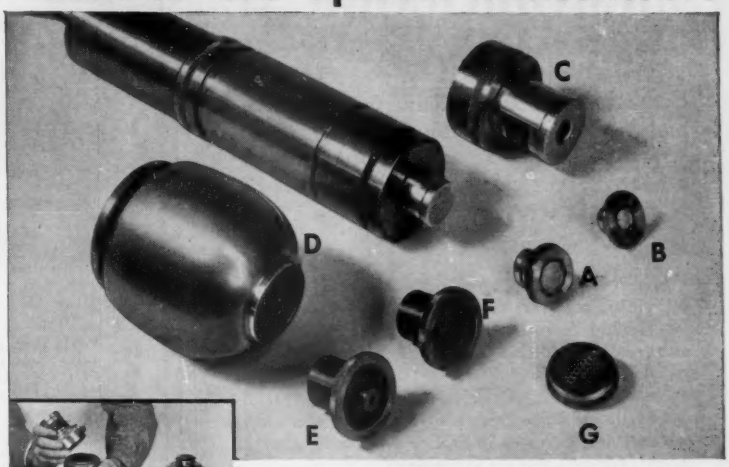

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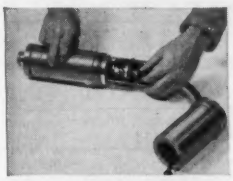

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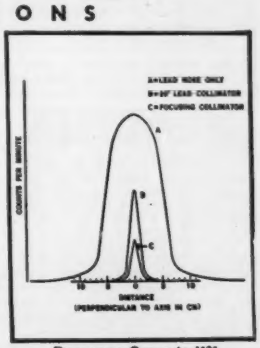

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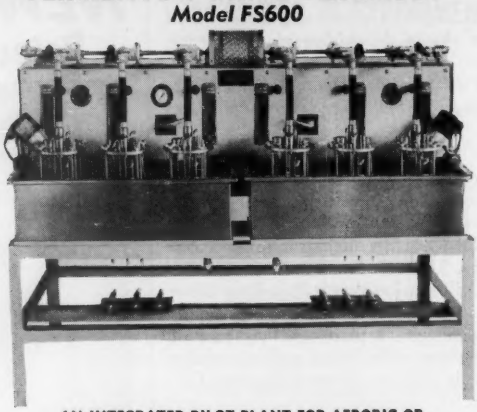

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APPLICATION FOR HOTEL RESERVATIONS

123rd AAAS MEETING

New York City, December 26-31, 1956

The list of hotels and their rates and the reservation coupon below are for your convenience in making your hotel room reservation in New York. Please send your application, *not* to any hotel directly, but to the AAAS Housing Bureau in New York and thereby avoid delay and confusion. (Members of the American Astronomical Society who wish reservations at uptown hotels should correspond directly with the Hayden Planetarium.) The experienced Housing Bureau will make assignments promptly; a confirmation will be sent you in two weeks or less. **As in any city, single-bedded rooms may become scarce; double rooms for single occupancy cost more; for a lower rate, share a twin-bedded room with a colleague.** Most hotels will place comfortable rollaway beds in rooms or suites at 2.50 or 3.00 per night. Mail your application *now* to secure your first choice of desired accommodations. All requests for reservations must give a definite date and estimated hour of arrival, and also probable date of departure.

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Rates for Rooms with Bath*

All hotels have sessions in their public rooms. For a list of headquarters of each participating society and section, please see *Science*, July 20, or *The Scientific Monthly* for August.

Hotel	Single	Double Bed	Twin Bed	Suite
Governor Clinton	$7.00–11.00	$10.00–13.00	$11.00–17.00	$20.00–35.00
Martinique	5.00– 9.00	8.00–14.00	8.00–14.00	16.00–38.00
New Yorker	7.00–10.00	10.00–14.00	11.50–17.00	25.00 and up
Sheraton-McAlpin	6.75– 9.75	9.75–12.75	10.75–13.75	20.00 and up
Statler	8.00–12.00	11.00–15.00	11.50–18.00	31.00–33.00

* Subject to 5% New York City tax on hotel rooms.

---------- **THIS IS YOUR HOUSING RESERVATION COUPON** ----------

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90 East 42nd Street
New York 17, N. Y.

Date of Application .....

Please reserve the following accommodations for the 123rd Meeting of the AAAS in New York City, Dec. 26–31, 1956:

TYPE OF ACCOMMODATION DESIRED

Single Room ..... Desired Rate ..... Maximum Rate .....

Double-Bedded Room ..... Desired Rate ..... Maximum Rate ..... Number in party .....

Twin-Bedded Room ..... Desired Rate ..... Maximum Rate .....

Suite ..... Desired Rate ..... Maximum Rate ..... Sharing this room will be:

(Attach list if this space is insufficient. The name and address of each person, including yourself, must be listed.)

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First Choice Hotel ..... **Second Choice Hotel** ..... **Third Choice Hotel** .....

DATE OF ARRIVAL ..... DEPARTURE DATE .....
(These must be indicated—add approximate hour, a.m. or p.m.)

NAME .....
(Individual requesting reservation) (Please print or type)

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Mail this now to the Housing Bureau. **Rooms will be assigned and confirmed in order of receipt of reservation.**

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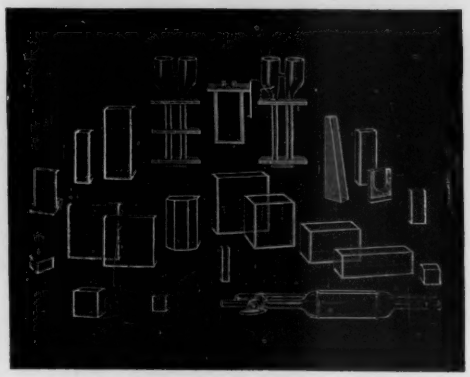

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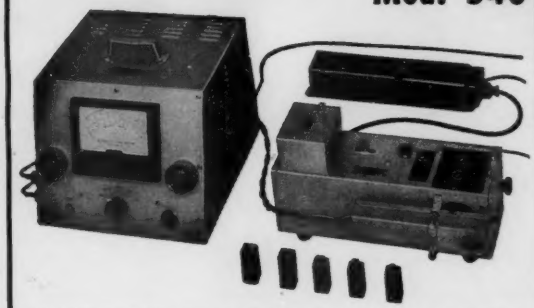

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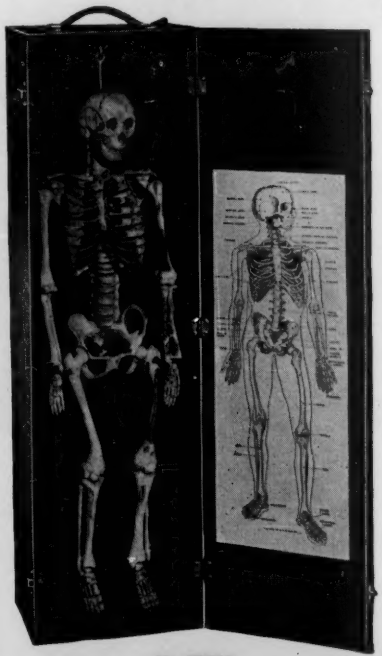

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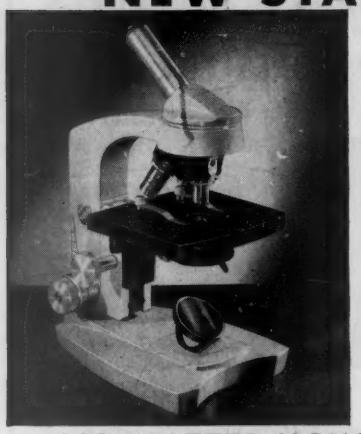
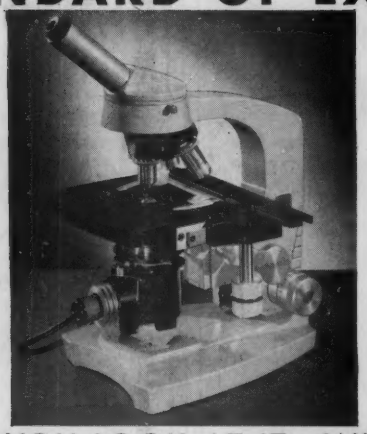
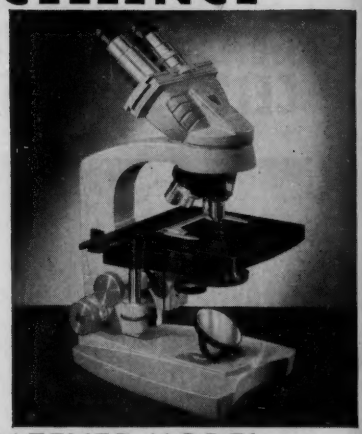

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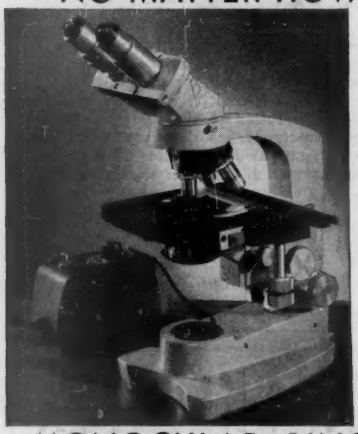
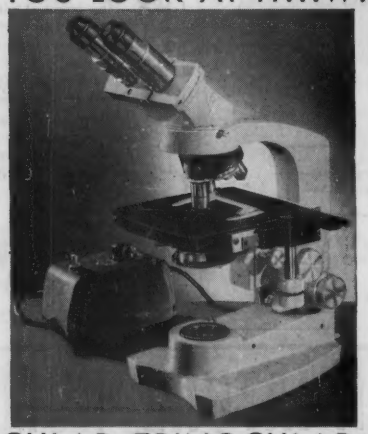
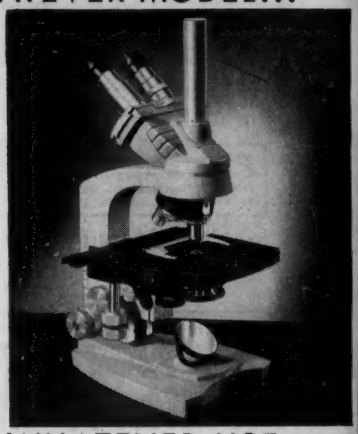

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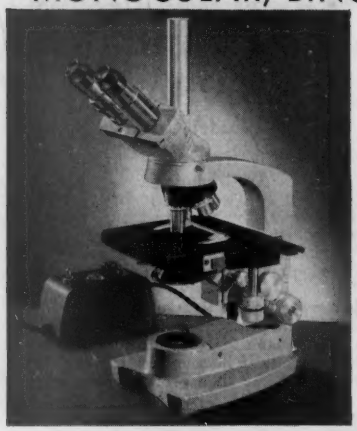
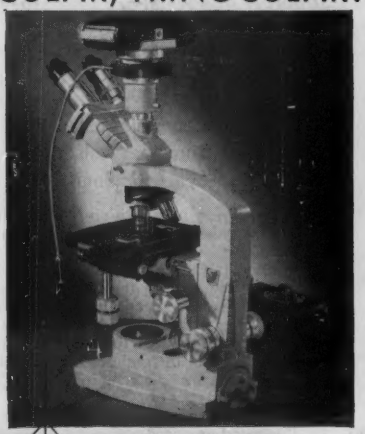
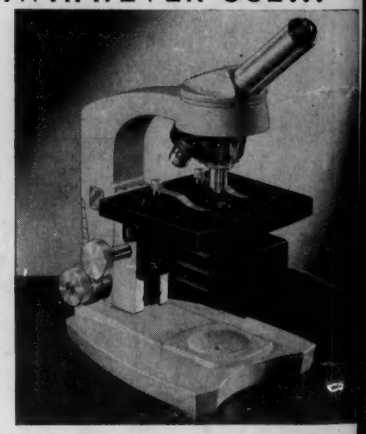

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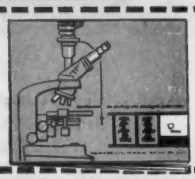

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